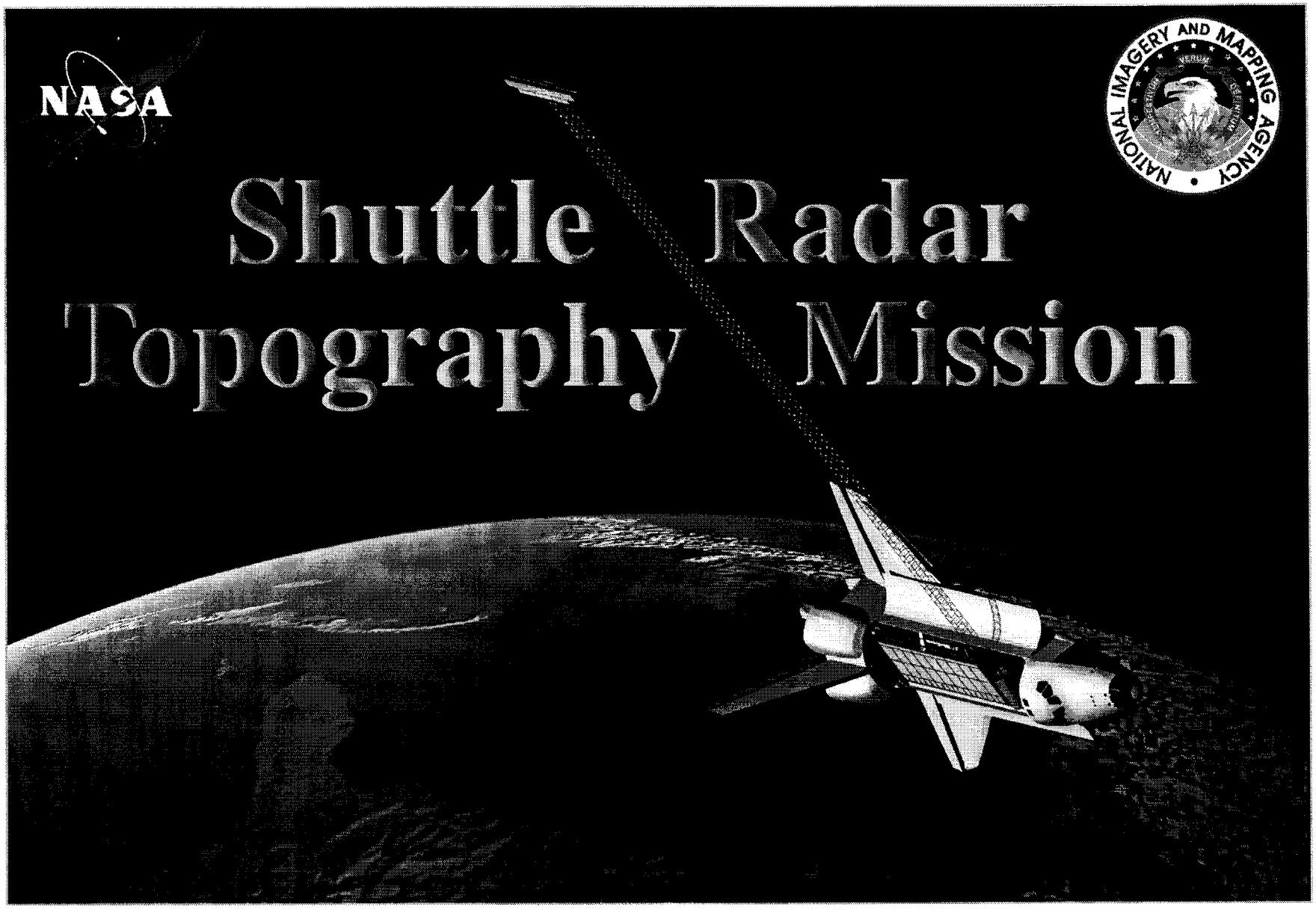

NASA
NATIONAL IMAGERY AND MAPPING AGENCY
Shuttle Radar Topography Mission

Mapping the World in Three Dimensions

The Shuttle Radar Topography Mission (SRTM) was a partnership between the National Imagery and Mapping Agency (NIMA), and the National Aeronautics and Space Administration (NASA). The German and Italian space agencies also contributed an experimental high-resolution imaging radar system.

- The purpose of the mission was to produce digital topographic data of 80% of Earth's land surface (all land areas between 60° north and 56° south latitude) with:
  - 30 meter horizontal resolution (1-arc second)
  - 10 meter relative height error
  - Globally consistent characteristics and datum
- The result has been the most accurate and complete topographical map of the Earth's surface ever assembled.
- The eleven-day mission flew from February 11-22, 2000, and mapped over 46 million square miles.

JPL

- Transmitted radar signals have known characteristics:
  - Amplitude
  - Polarization
  - Phase and Time Reference
  - Wavelength or Frequency
- A distant object that scatters the radar signal back toward the receiver alters the amplitude, polarization and phase, differently for different wavelengths.
- Comparison of the received signal characteristics to the transmitted signal allows us to understand the properties of the object.
- This is the principle of active remote sensing.

Kliuchevskoi Volcano, Russia, September 1994 eruption.

Shuttle Photograph

Radar Image

SIR-C/X-SAR images

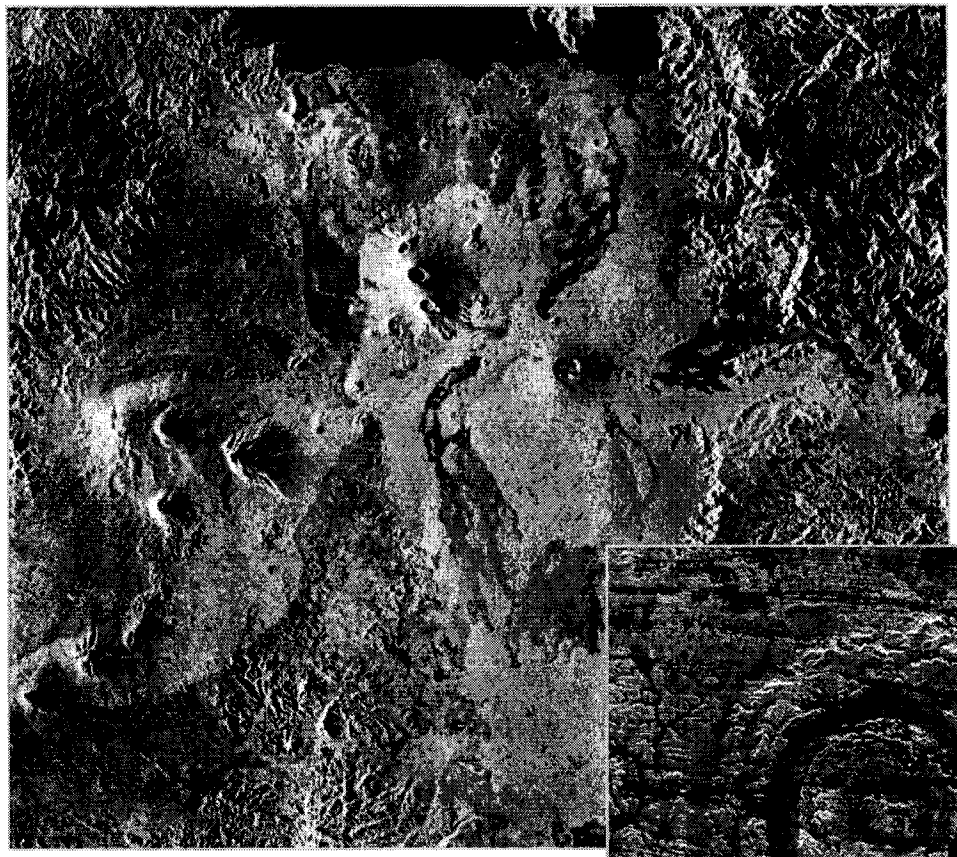
Radar signal penetrates dry sand, revealing bedrock structure below.

Optical Imagery

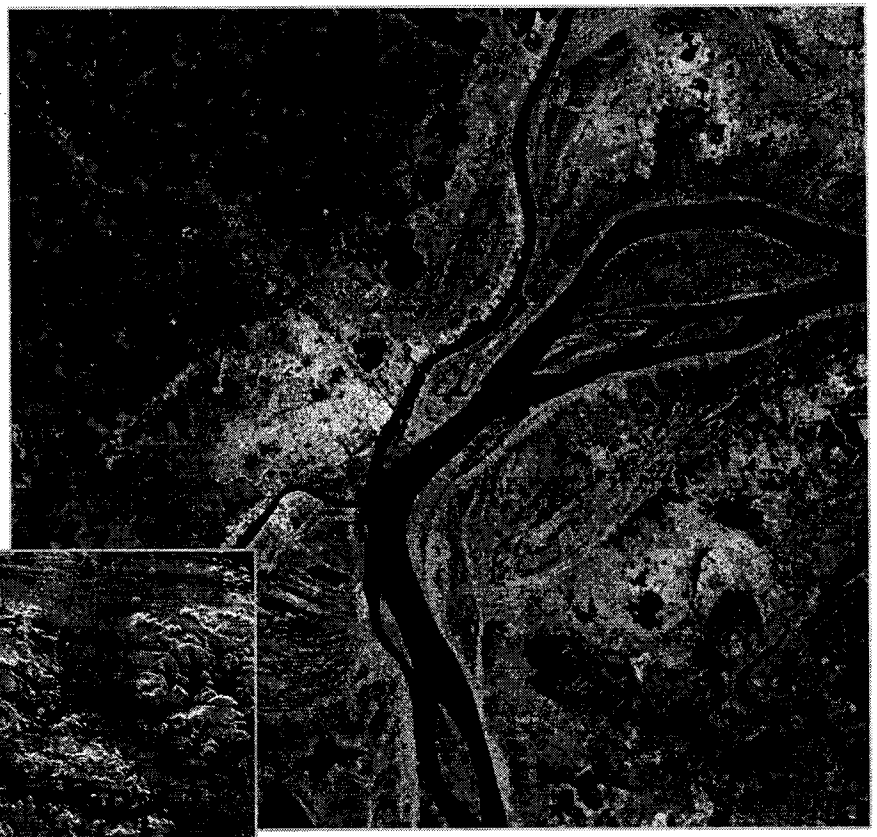
L-band (24 cm) SIR-A Observation

Northwest Sudan: Selma Sand Sheet

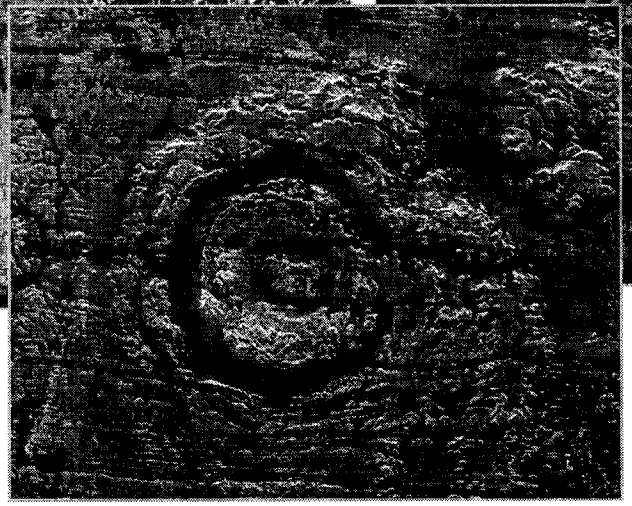
Applications:
Desertification/Environment
Geology/Geomorphology
Archaeology



Volcanoes



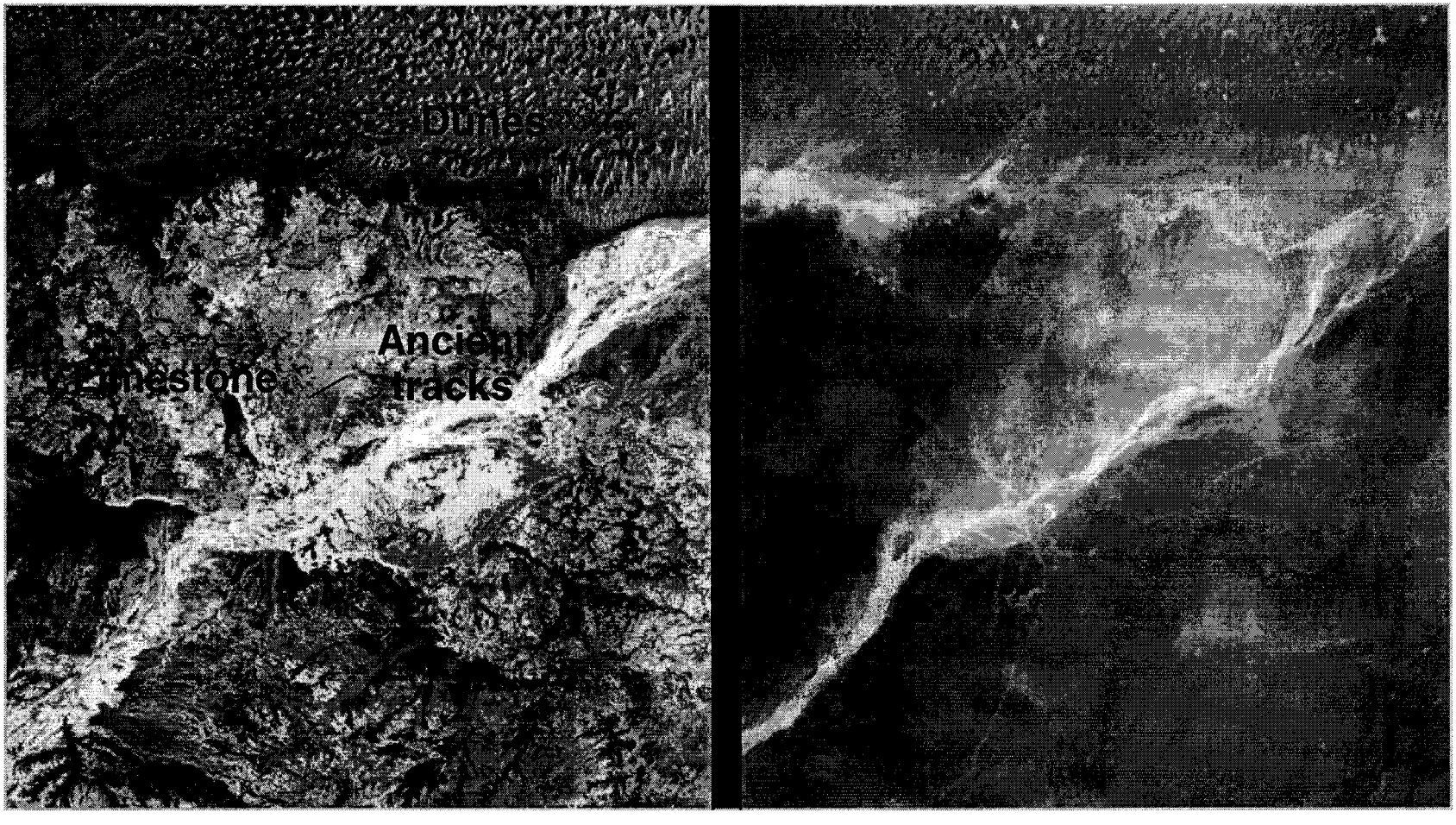
Urban Centers



Geology

SIR-C/X-SAR images

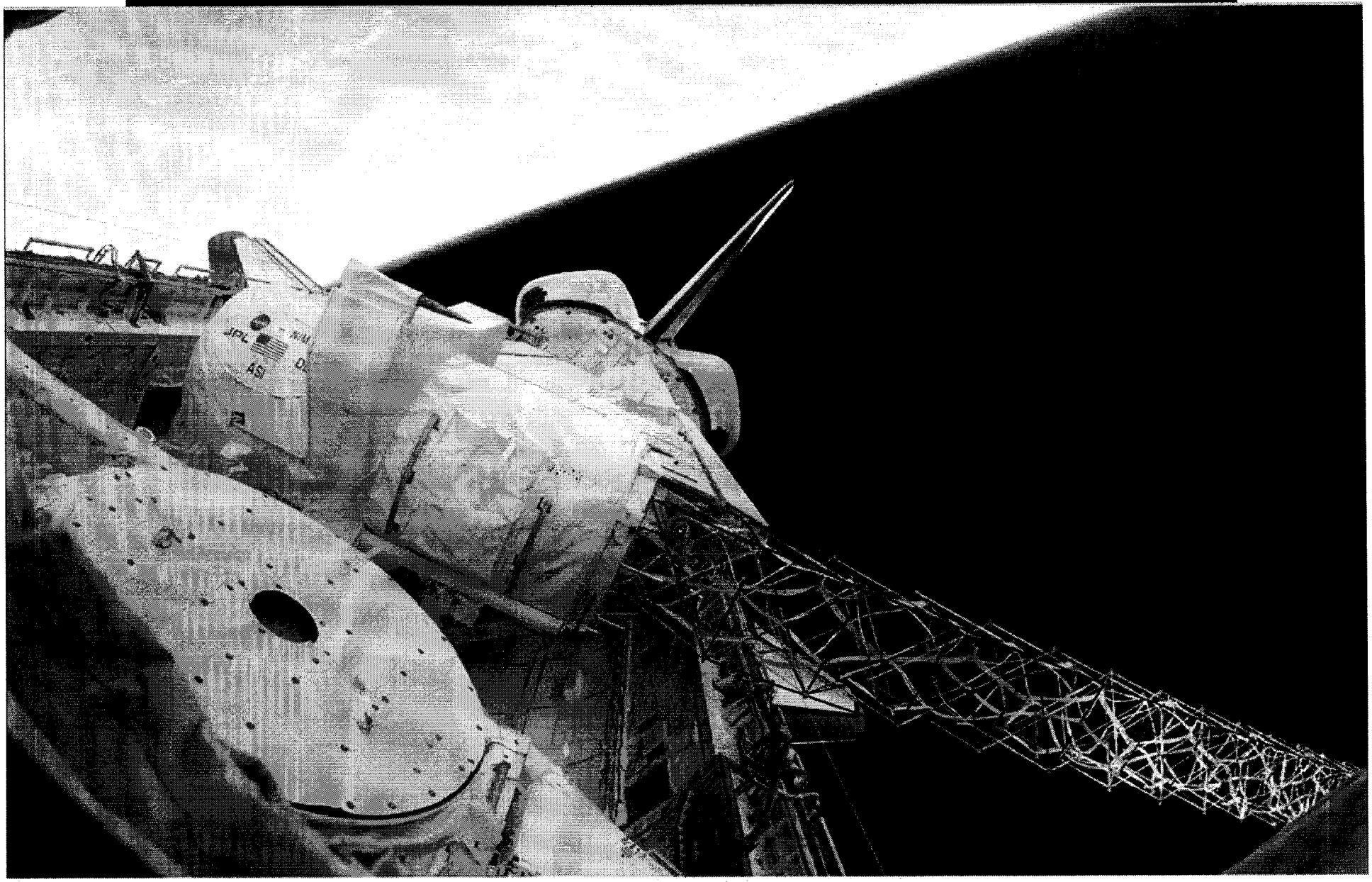
Ubar is too small to be seen, but ancient tracks leading to it are visible.



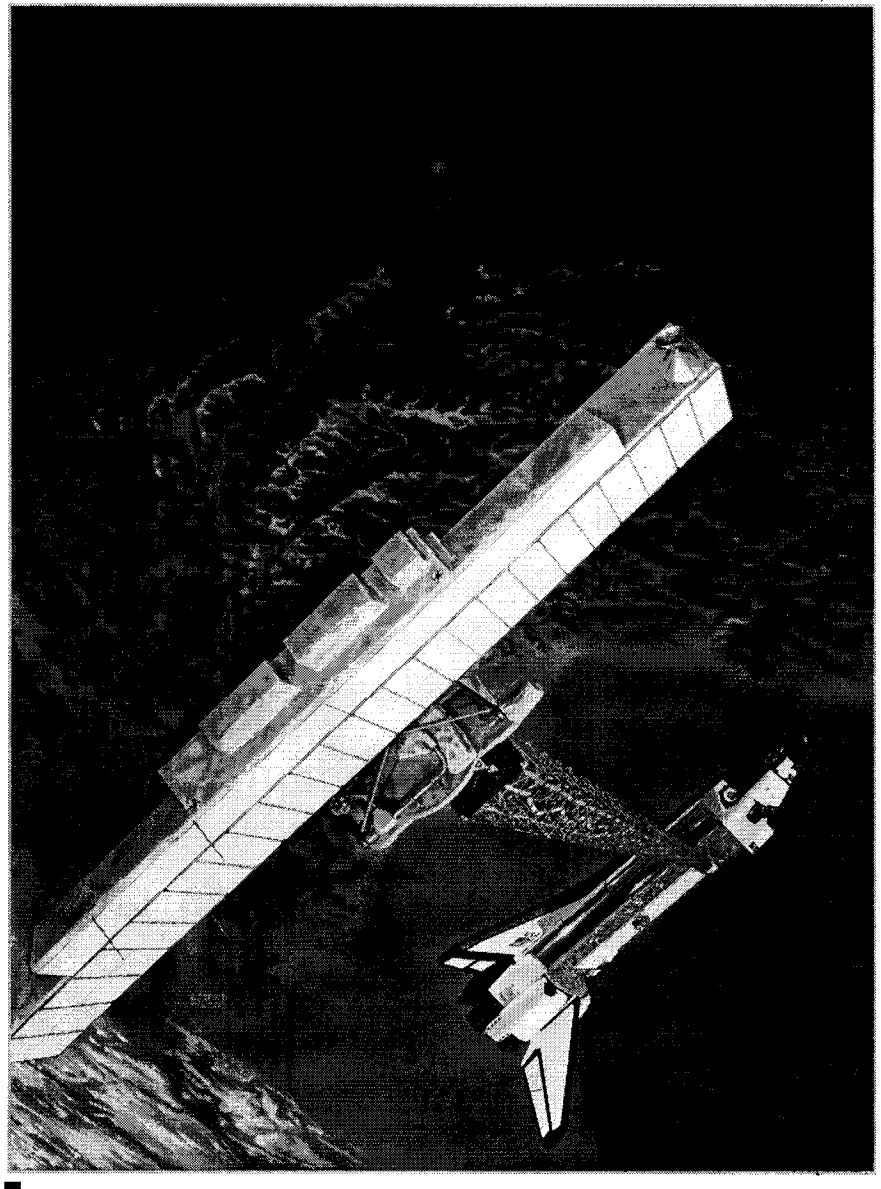
SIR-C Multi-parameter SAR

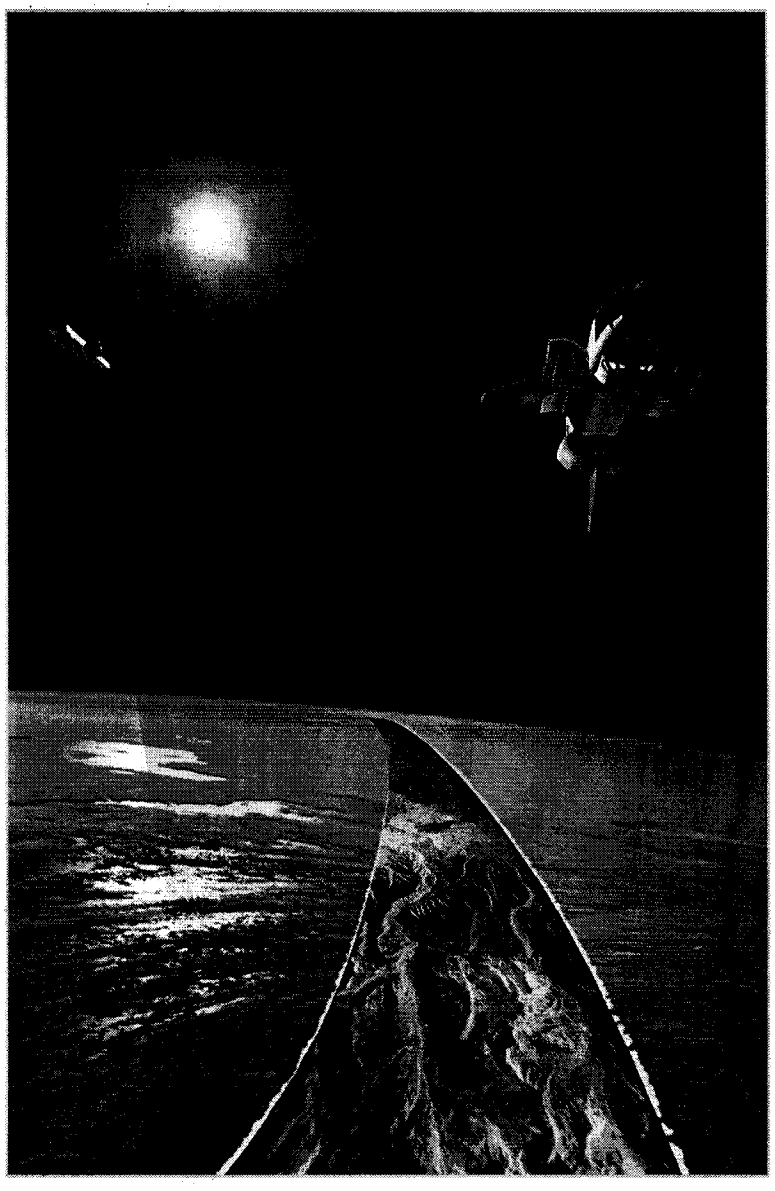
red - LHH; blue - CHH; green - LHV

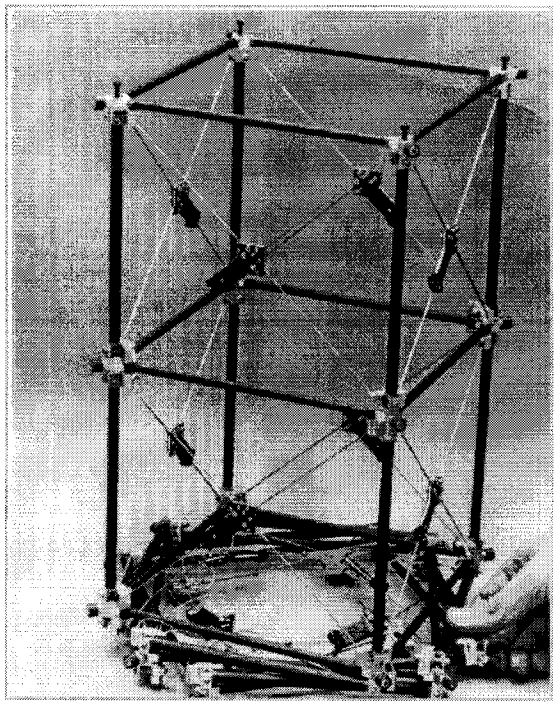
Enhanced Shuttle Optical

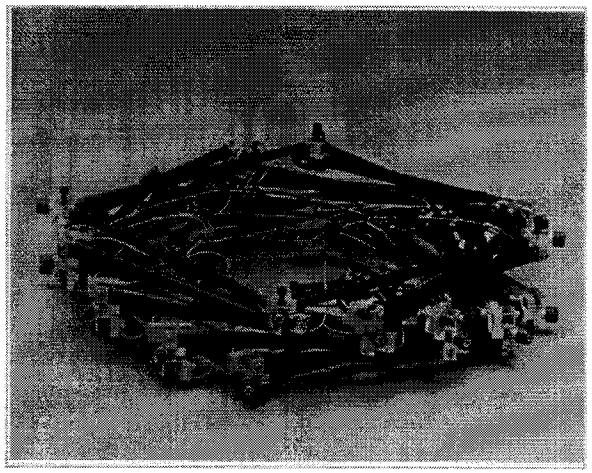


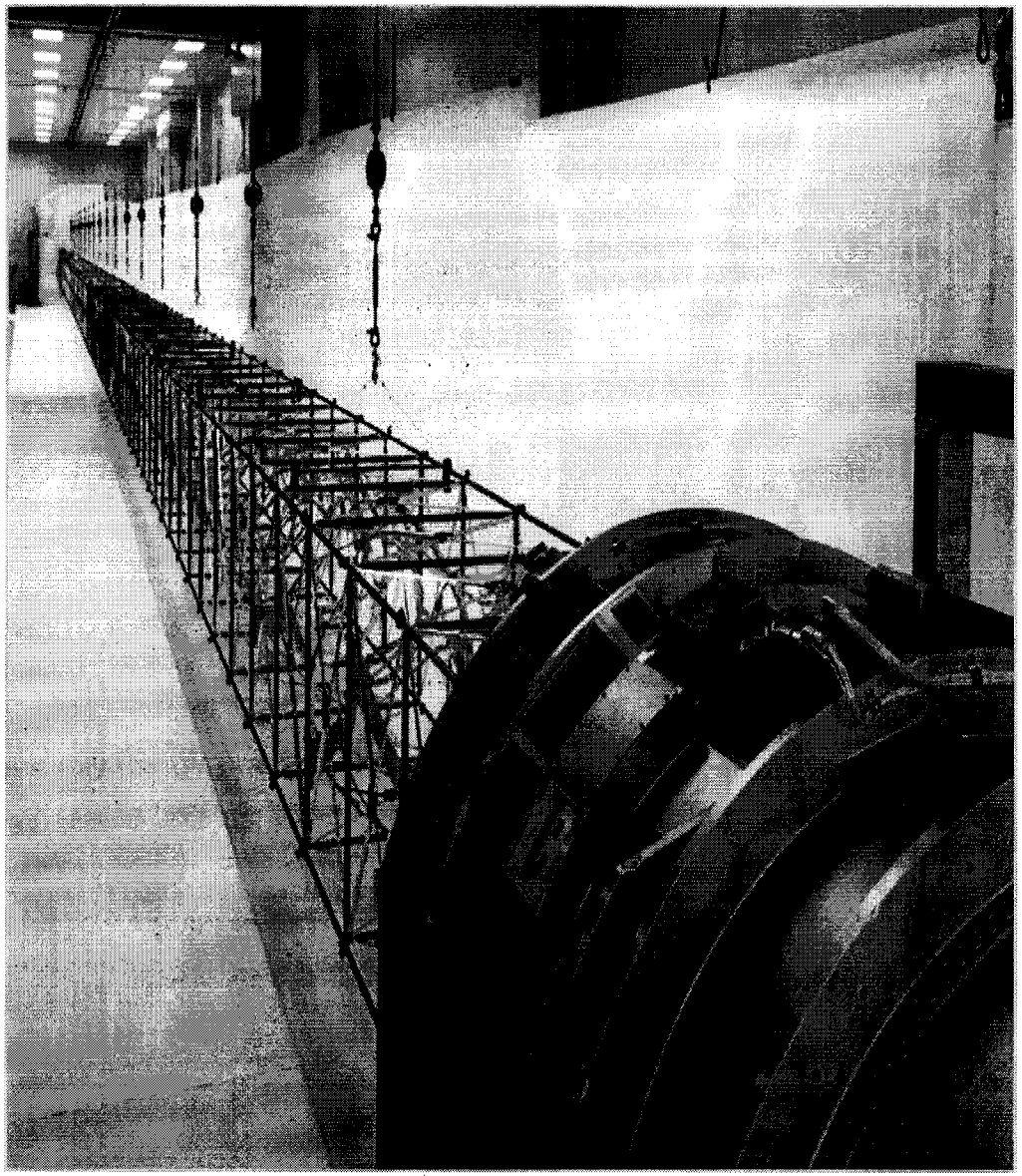
S99E5476 2000:02:16 06:09:32

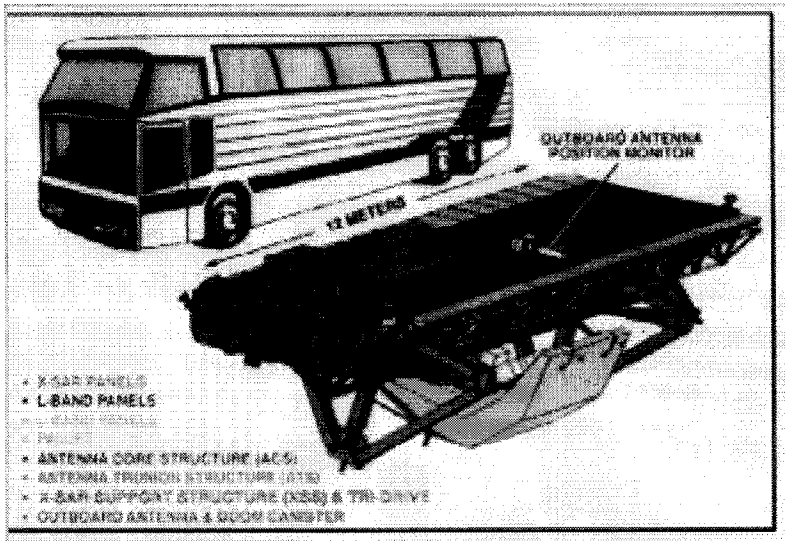




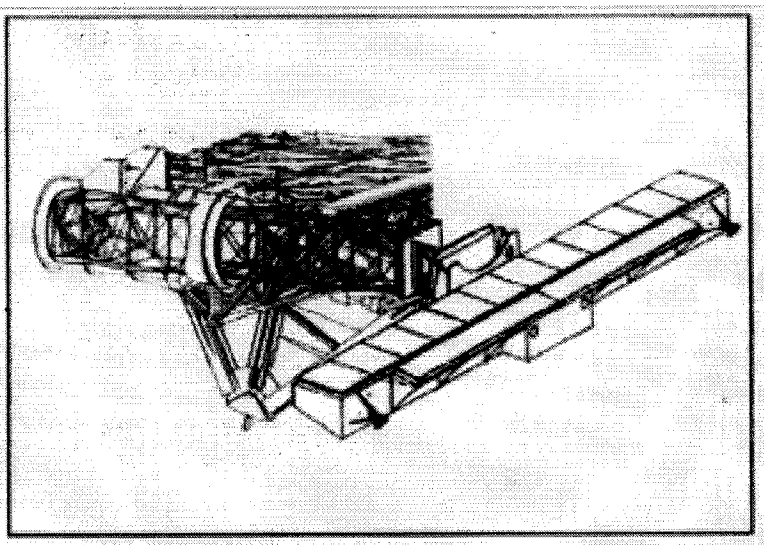




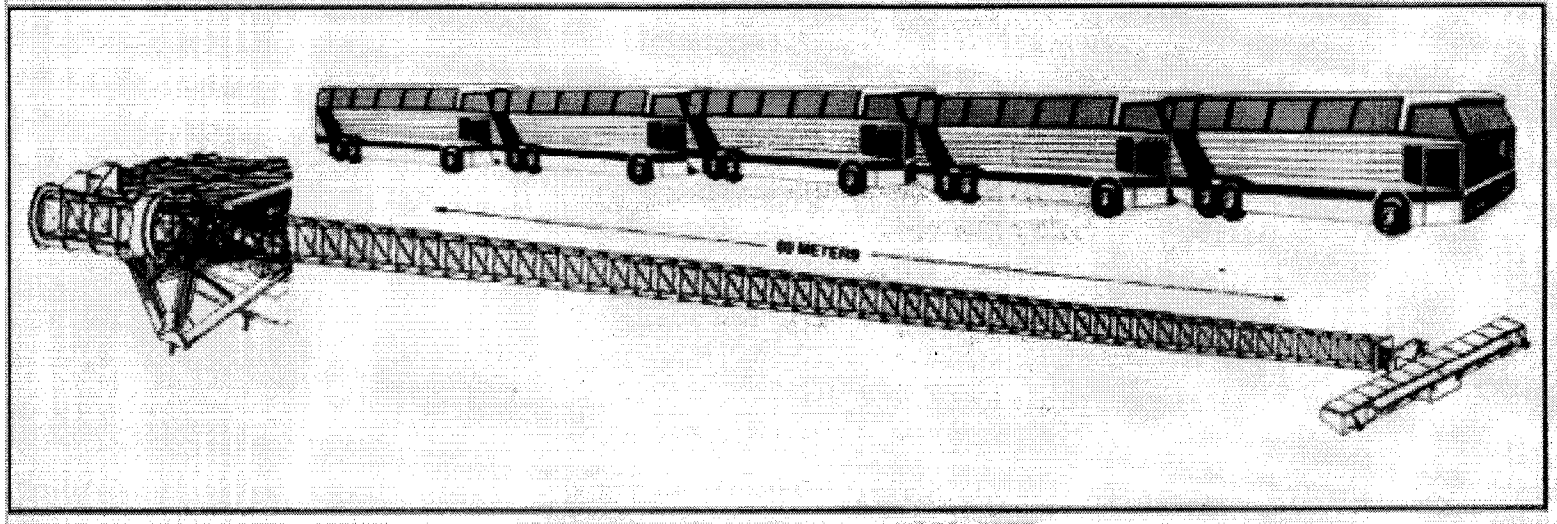




SRTM OUTBOARD ANTENNA STOWED

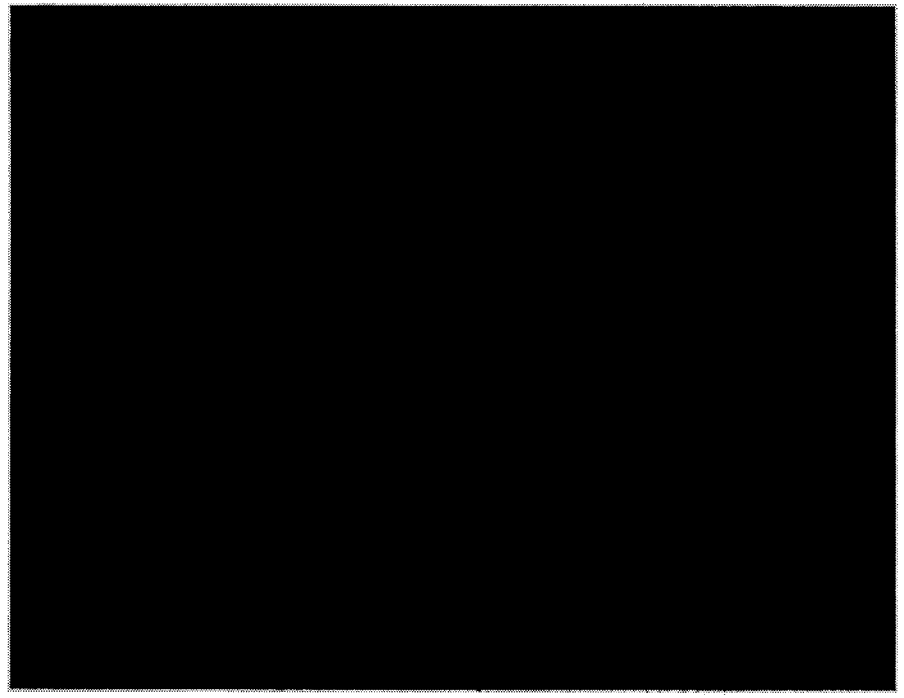


SRTM OUTBOARD ANTENNA PARTIALLY DEPLOYED

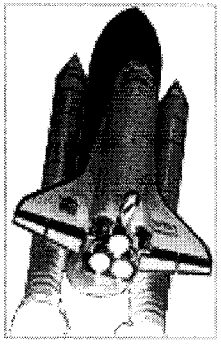


SRTM OUTBOARD ANTENNA FULLY DEPLOYED

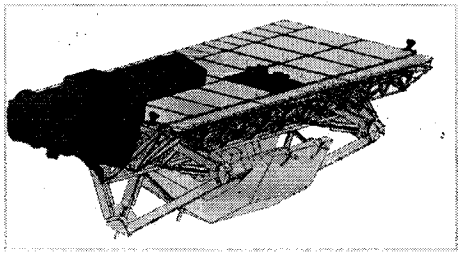
[redacted]



Launch: Endeavour (STS-99) launched February 11, 2000, on an 11-day flight.

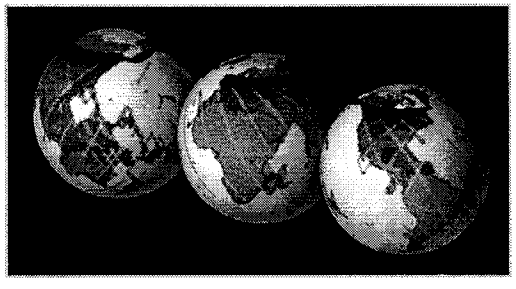


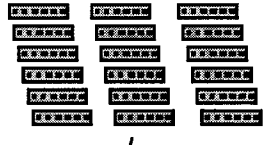
Reflown hardware: Primary antenna and support structure, RF electronics, command/telemetry system, power distribution system, digital data system, recorders, target tracker, attitude gyros.



New hardware: Mast and canister, secondary antenna, star tracker, GPS.

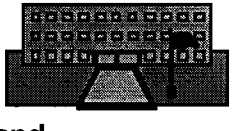
225 km interferometric swaths mapped all landmass between ±60° latitude.



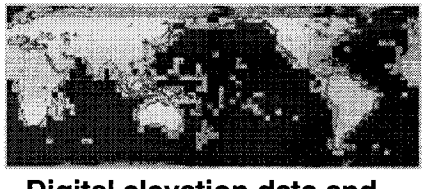


Data recorded on-board:
~ 8.6 TBytes C-band
~ 3.7 TBytes X-band

Data returned with shuttle to Ground Data Processing Facility at JPL.



Two years processing, verification and validation.

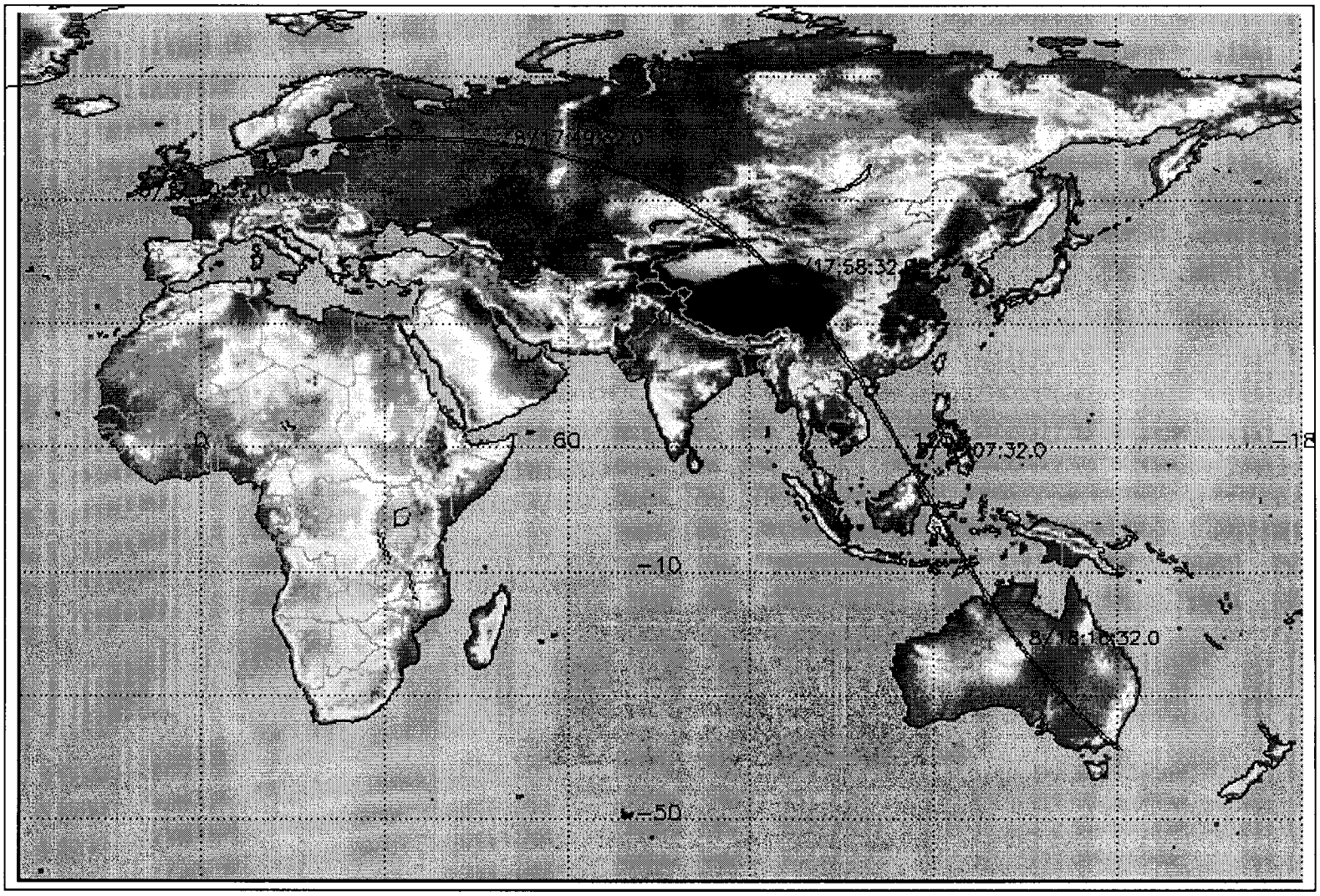


Digital elevation data and images delivered in mosaicked blocks.

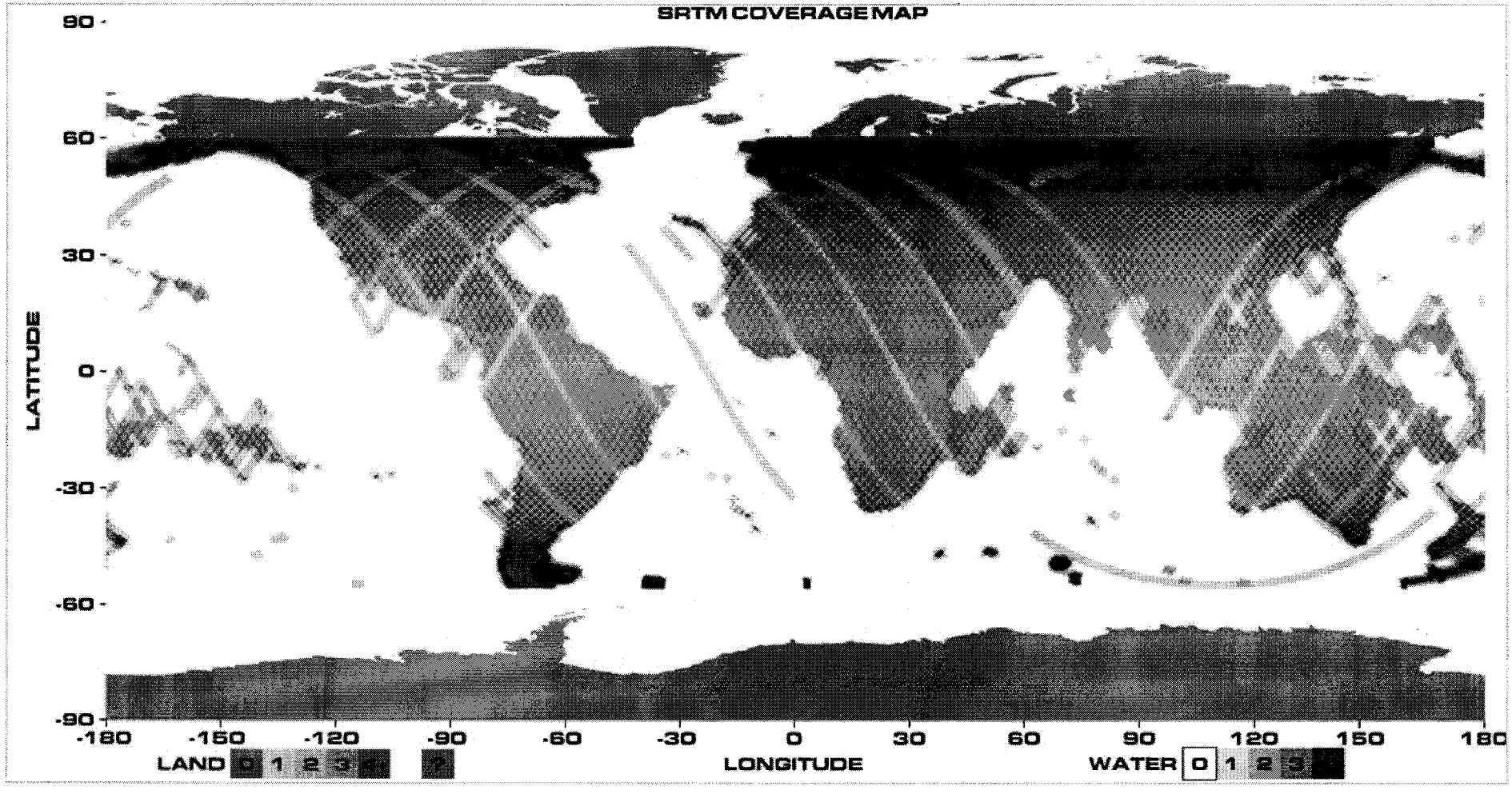
US Geological Survey EROS Data Center

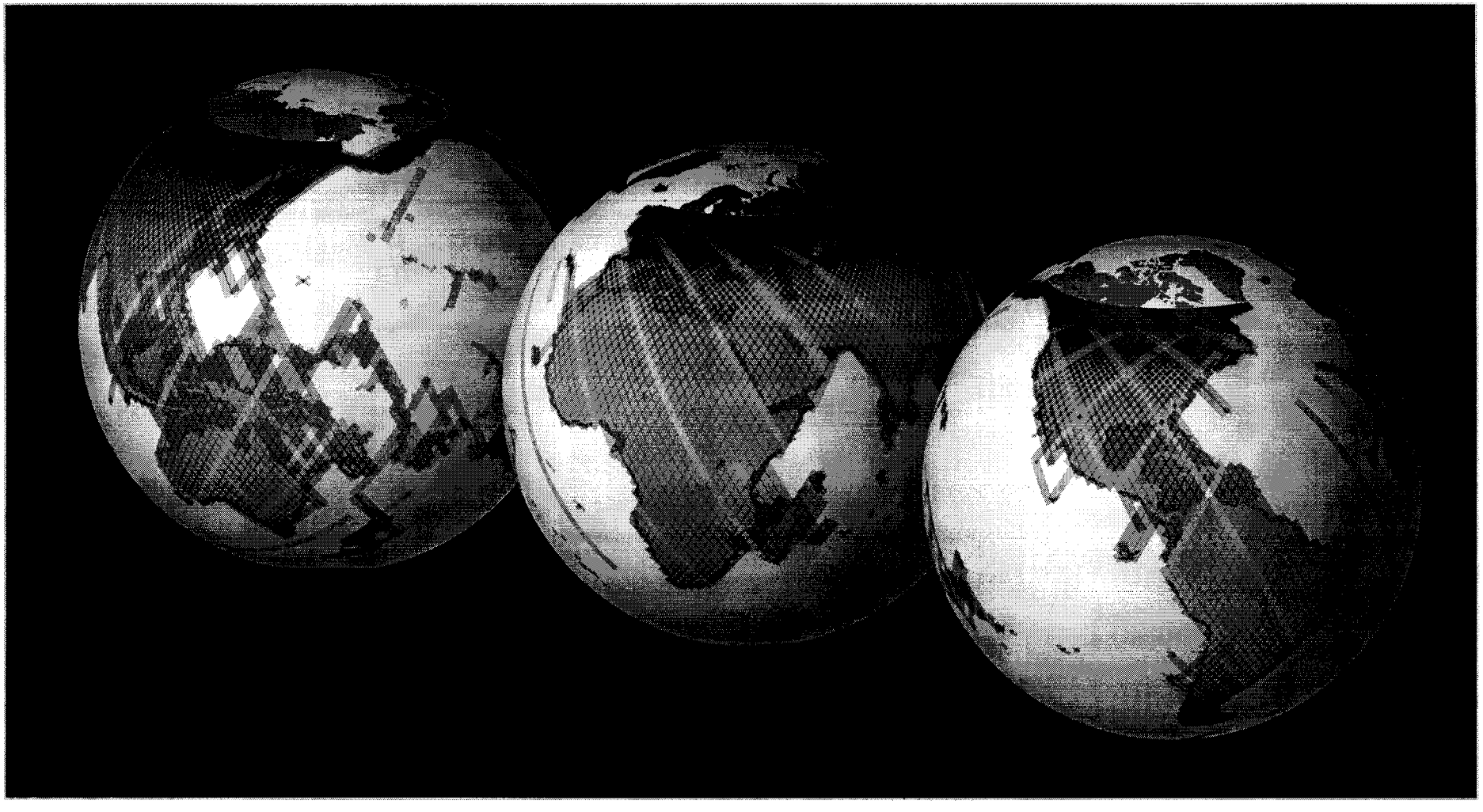
Civilian archive and distribution.

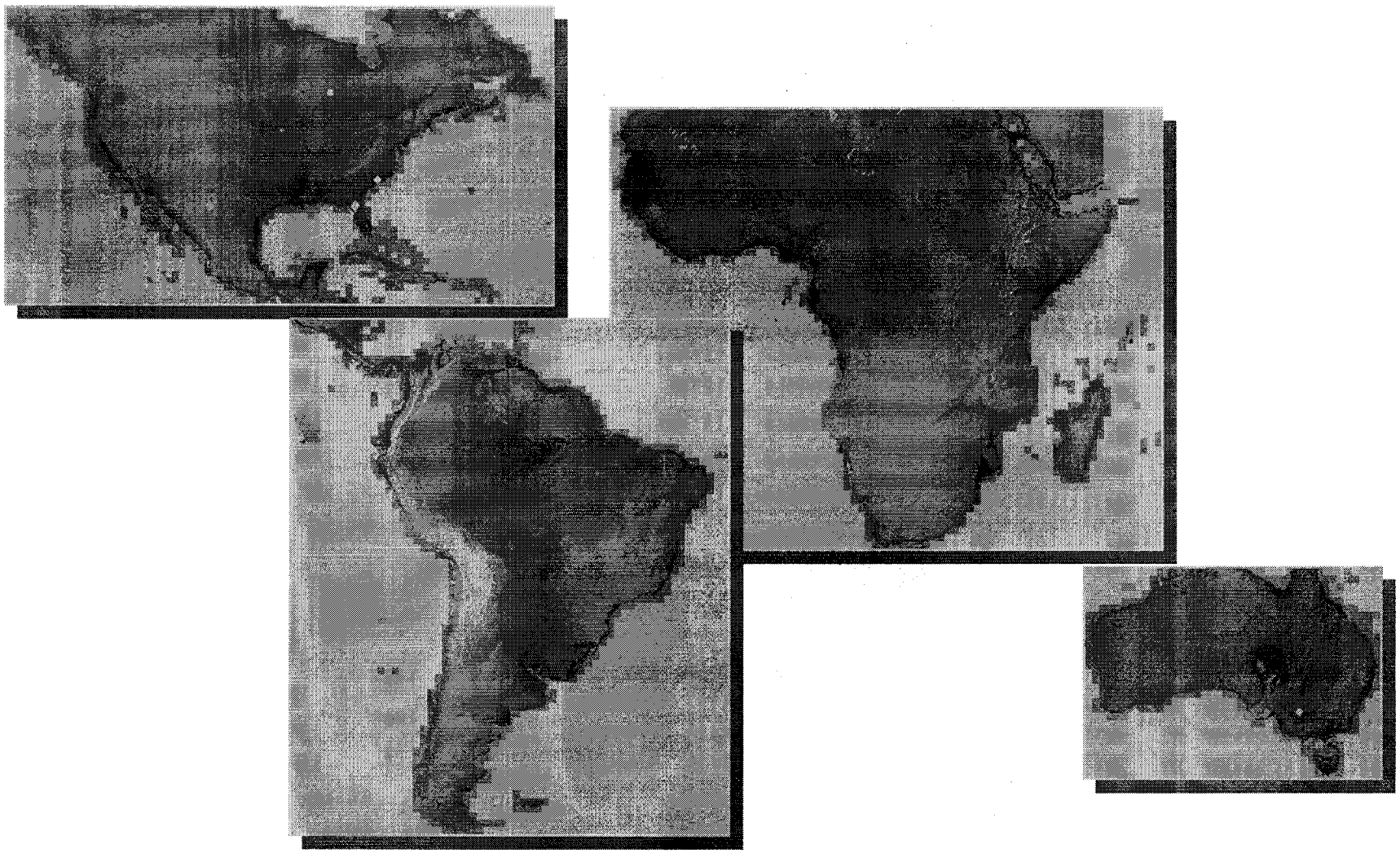
NIMA product generation and distribution to Department of Defense users.



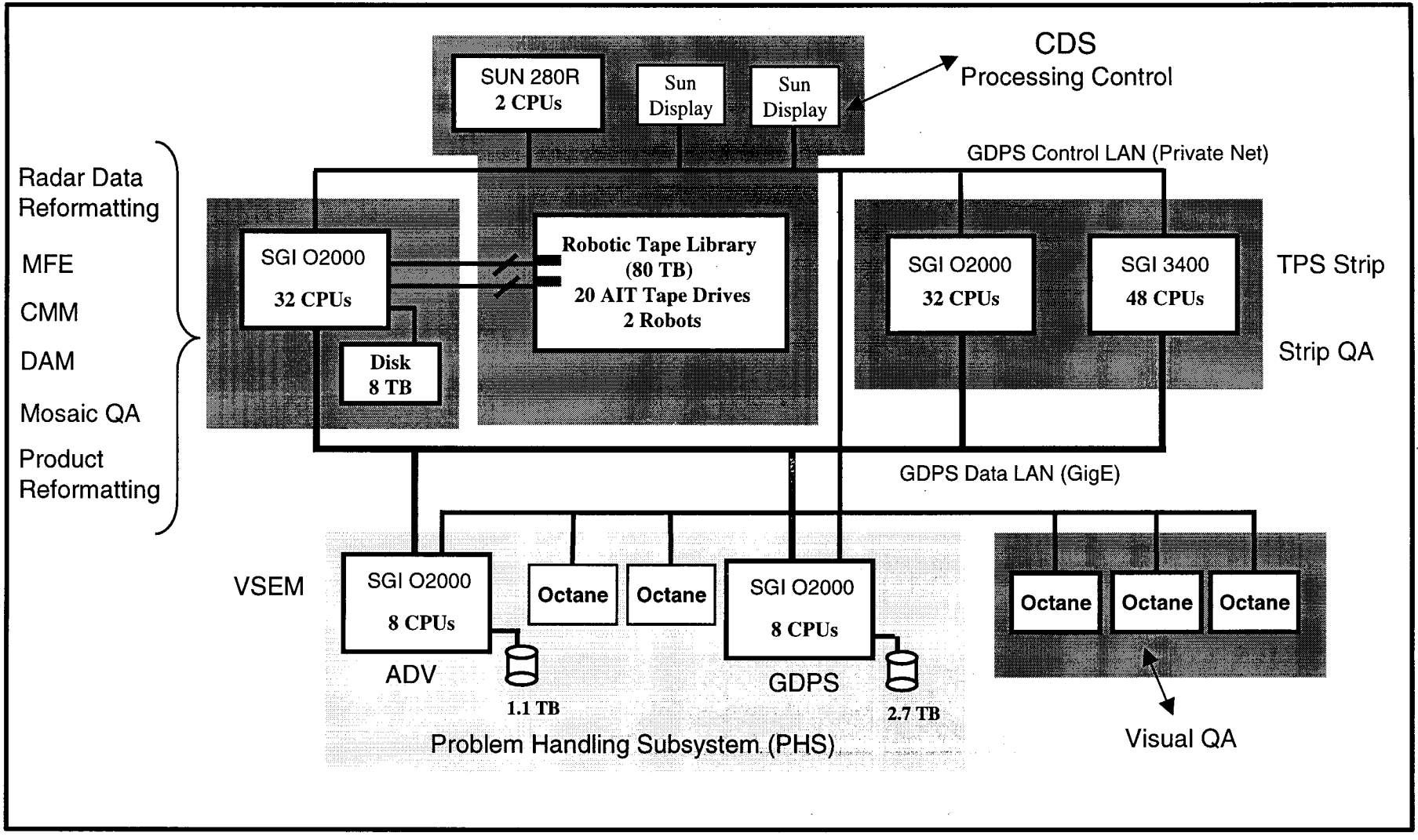
d:\mpusar\x\dt_plots\CX_142_050.GIF created 17-NOV-1999 19:34 GMT
G/T: 0/11:50:00.0 to 10/08:30:00.0

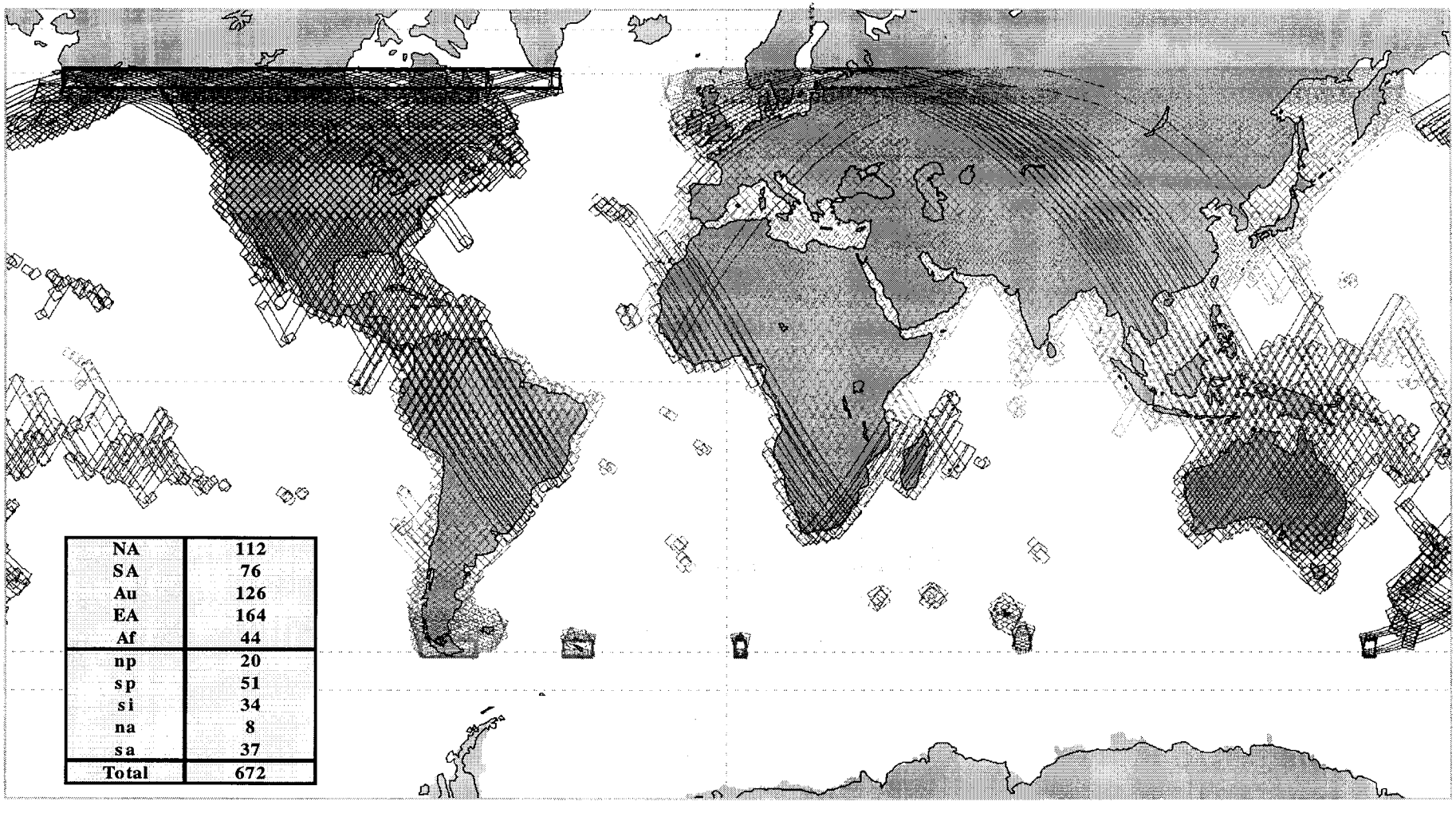

SRTM COVERAGE MAP
90
60
30
0
-30
-60
-90
LATITUDE
-180
-150
-120
-90
-60
-30
0
30
60
90
120
150
180
LONGITUDE
LAND 0 1 2 3 4
?
WATER 0 1 2 3





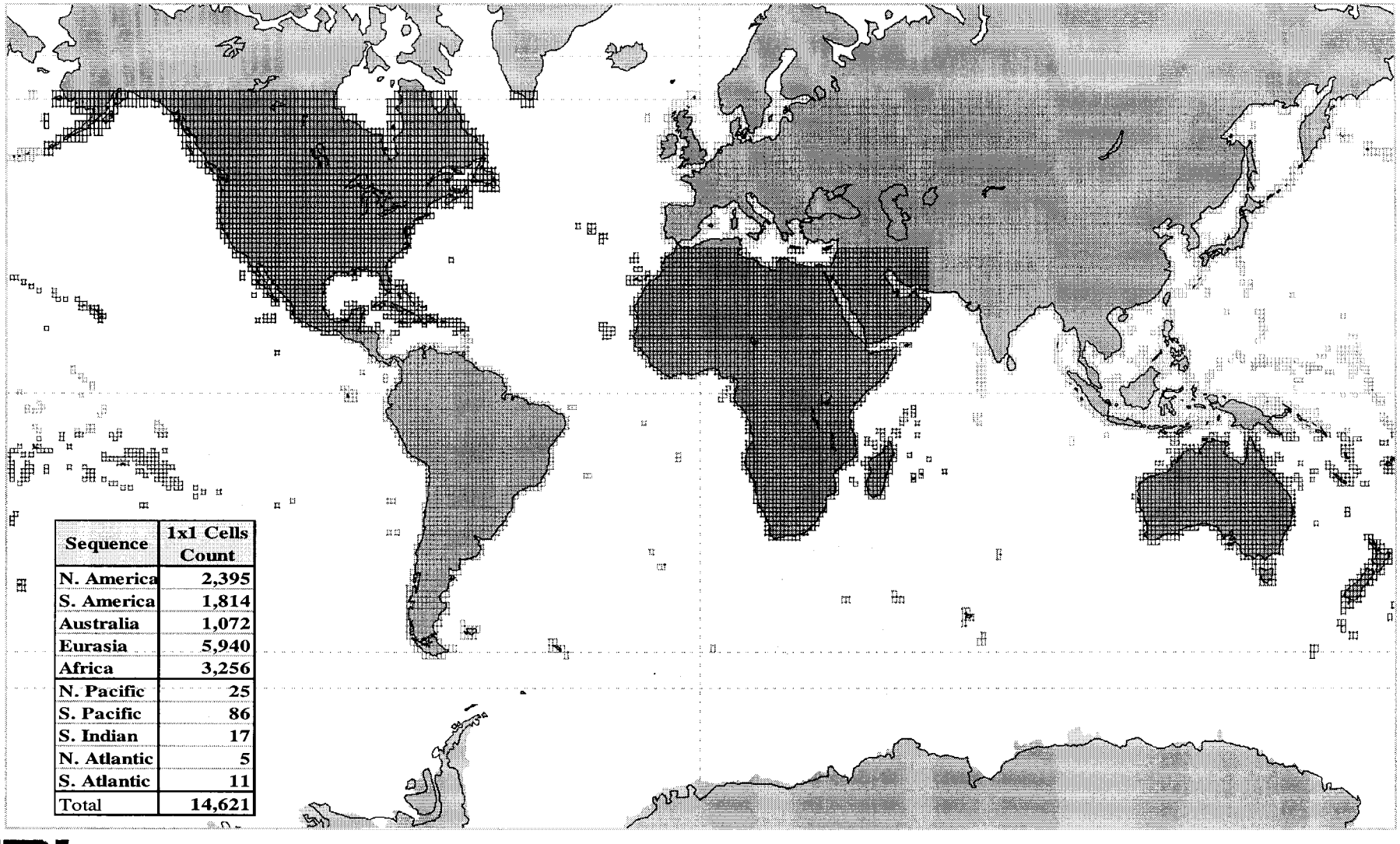
* “Continent” defined by processing convention, not geography.


CDS
Processing Control
SUN 280R
2 CPUs
Sun
Display
Sun
Display
GDPS Control LAN (Private Net)
Radar Data
Reformatting
MFE
CMM
DAM
Mosaic QA
Product
Reformatting
SGI O2000
32 CPUs
Disk
8 TB
Robotic Tape Library
(80 TB)
20 AIT Tape Drives
2 Robots
SGI O2000
32 CPUs
SGI 3400
48 CPUs
TPS Strip
Strip QA
GDPS Data LAN (GigE)
VSEM
SGI O2000
8 CPUs
ADV
1.1 TB
Octane
Octane
SGI O2000
8 CPUs
GDPS
2.7 TB
Problem Handling Subsystem (PHS)
Octane
Octane
Octane
Visual QA



NA	112
SA	76
Au	126
EA	164
Af	44
np	20
sp	51
si	34
na	8
sa	37
Total	672

[redacted]

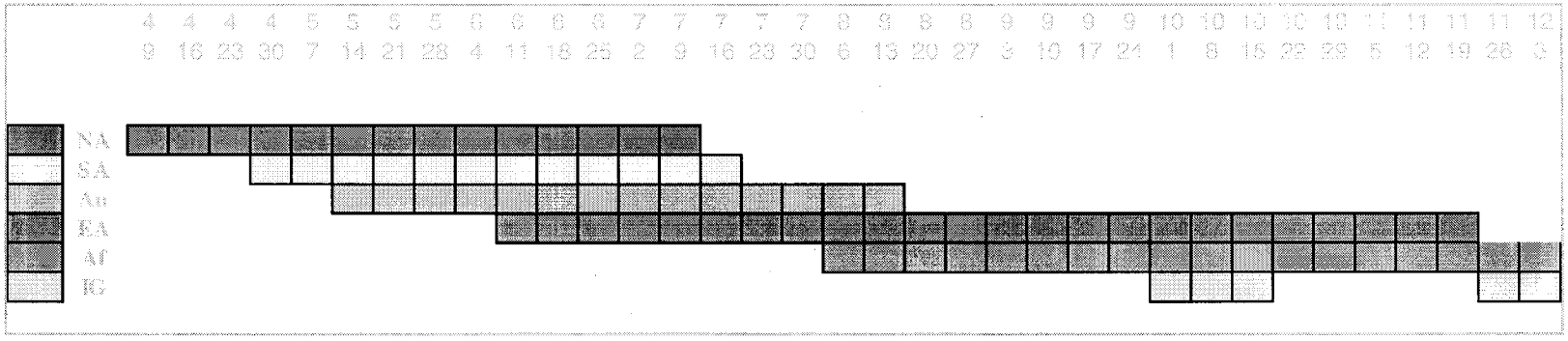


Sequence	1x1 Cells Count
N. America	2,395
S. America	1,814
Australia	1,072
Eurasia	5,940
Africa	3,256
N. Pacific	25
S. Pacific	86
S. Indian	17
N. Atlantic	5
S. Atlantic	11
Total	14,621

JPL

Sequence	Data Hours	1x1 Cells Count	5x5 Cells Count	Total Days
N. America				
S. America				
Australia				
Eurasia				
Africa				
N. Pacific				
S. Pacific				
S. Indian				
N. Atlantic				
S. Atlantic				
Total				

JPL

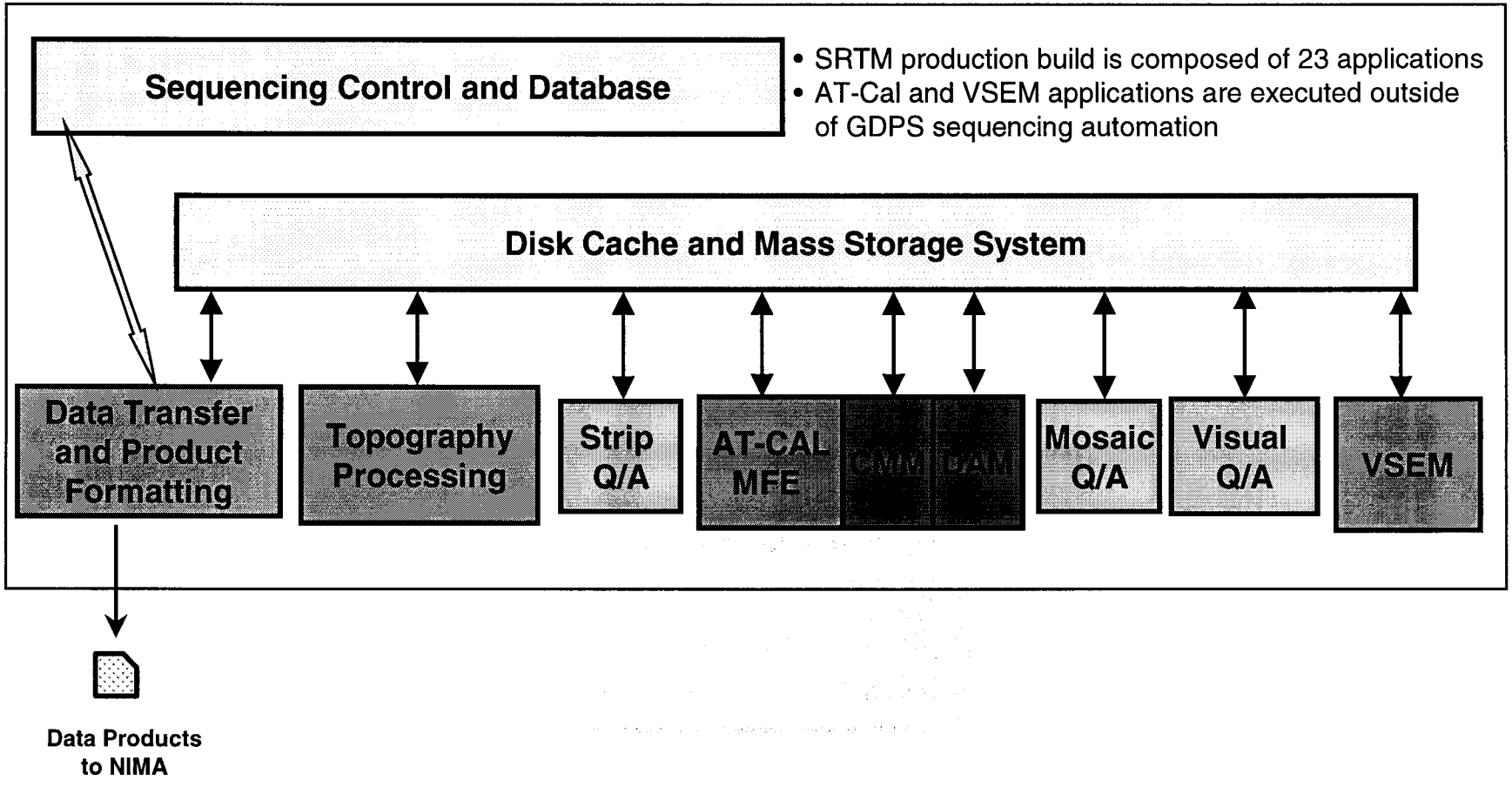


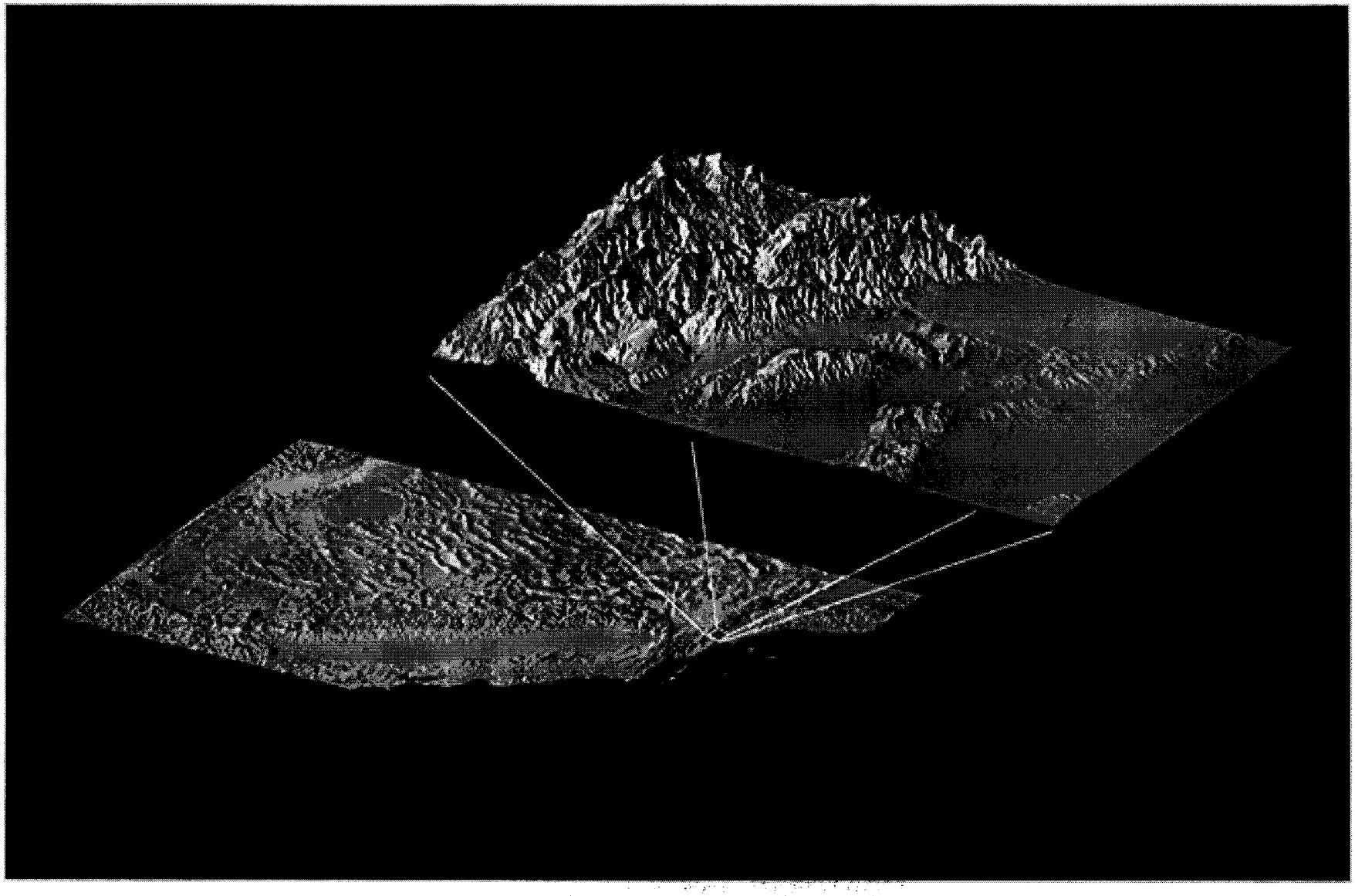
Group	Deliver on or before
NA	July 10
SA	Aug 6
Au	Aug 13
EA	Nov 17
Af	Dec 6
IG	Dec 16

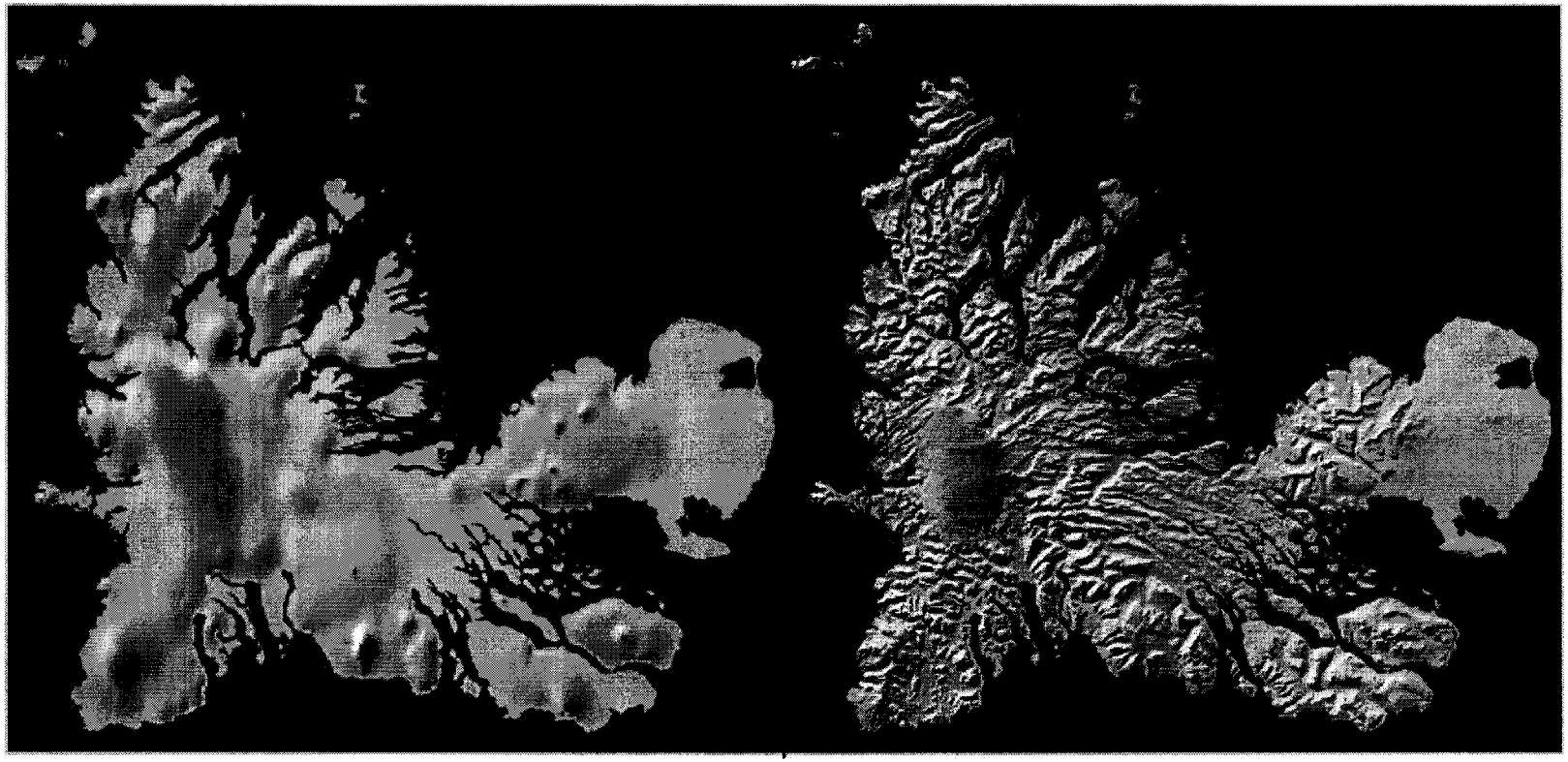
- Project schedule:
  - Post-processing support phase (January 1, 2003 - March 31, 2003
  - NASA data archival phase (April 1, 2003 - May 31, 2003)

- Compute-intensive tasks:
  - Strip processing – 60 x acquisition time @ 4 nodes
  - Strip re-processing – ≈ 50% of strip processing time
  - Mosaic (DAM) – 6 hours per 5°x 5° cell @ 13 nodes
- Human-intensive tasks:
  - Continental correction (MFE) – 10 working days / continent
  - Visual QA (MSC) – 150 1°x1° cells / workday
  - Vertical Systematic Error Modelling (VSEM) – 10 working days / 3000 1°x1° cells

- Other applications provide smaller contribution to schedule and are often concurrent to intensive computing processes:
  - Sequence generation
  - Database processing
  - Raw data input transfer
  - Topographic pre-processing
  - Strip QA
  - Mosaic QA
  - Output data product generation (write and verify) (2 sets of tapes per day)


Sequencing Control and Database
• SRTM production build is composed of 23 applications
• AT-Cal and VSEM applications are executed outside of GDPS sequencing automation
Disk Cache and Mass Storage System
Data Transfer and Product Formatting
Topography Processing
Strip Q/A
AT-CAL MFE
CMM
DAM
Mosaic Q/A
Visual Q/A
VSEM
Data Products to NIMA

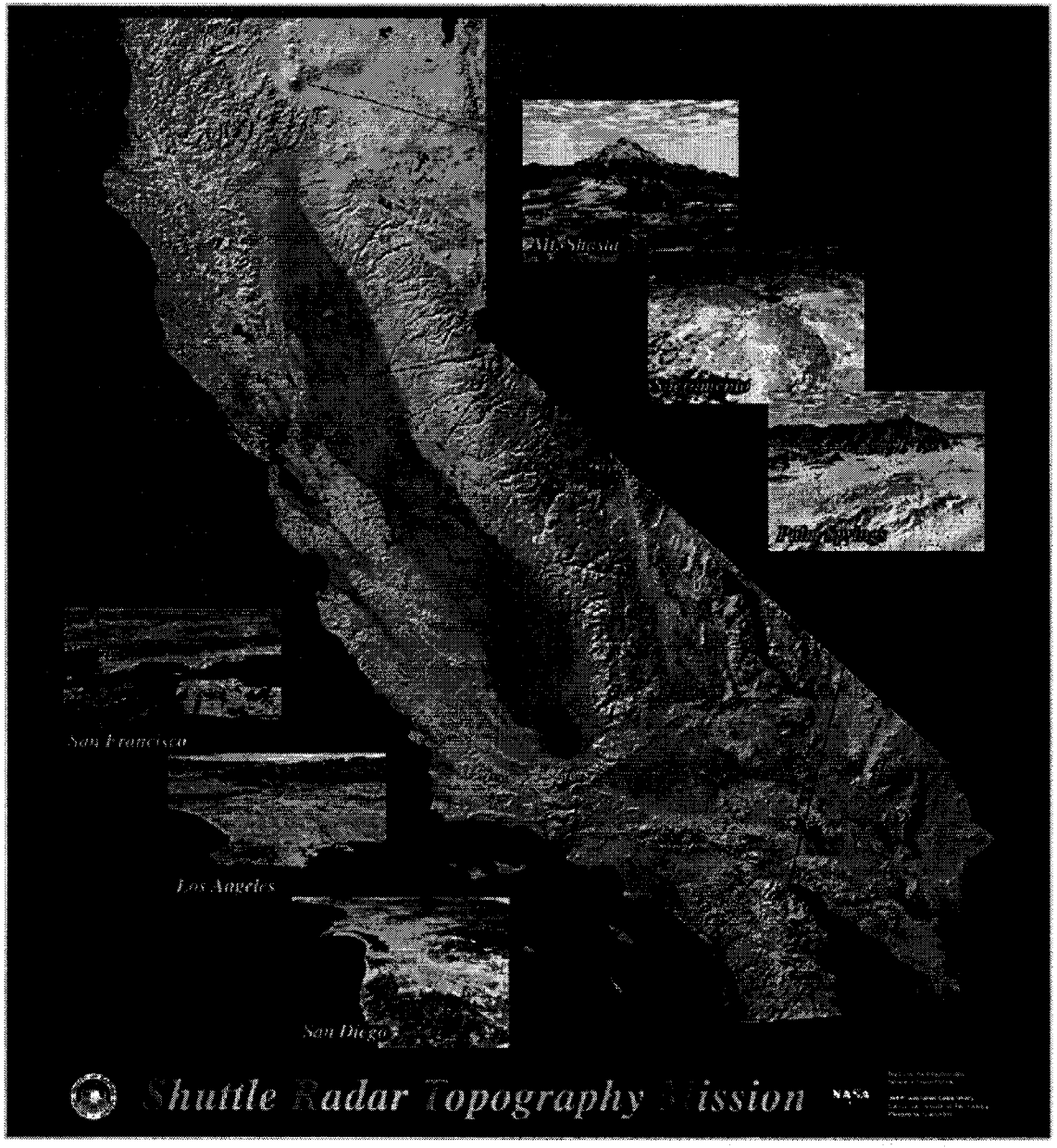




USGS GTOPO30 data

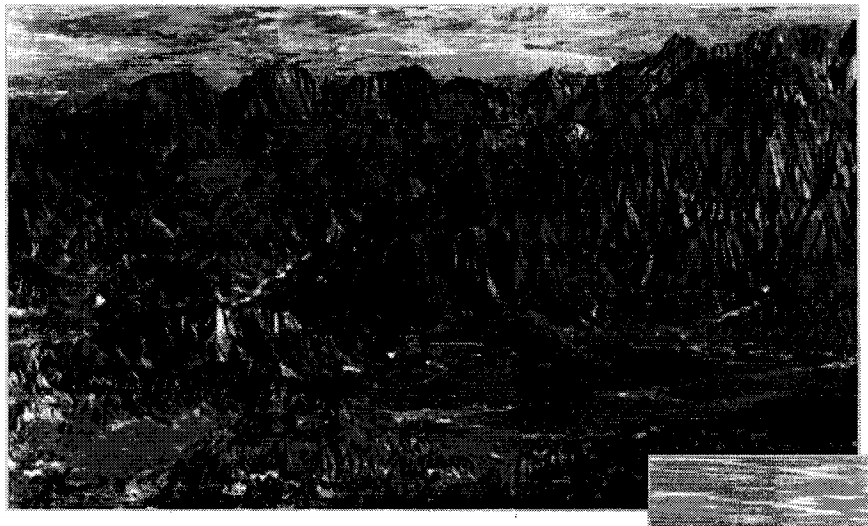
SRTM data

For some parts of the globe, SRTM measurements are 30 times more precise than previously available topographical information.



- This map image mosaic was generated by combining two visualization methods: shading and color coding of topographical height.
- The three-dimensional perspective inset views were generated from SRTM data and enhanced LandSat satellite image mosaics.

These 3D perspective views were generated using topographical data from the SRTM, and enhanced colour Landsat images.



San Fernando Valley

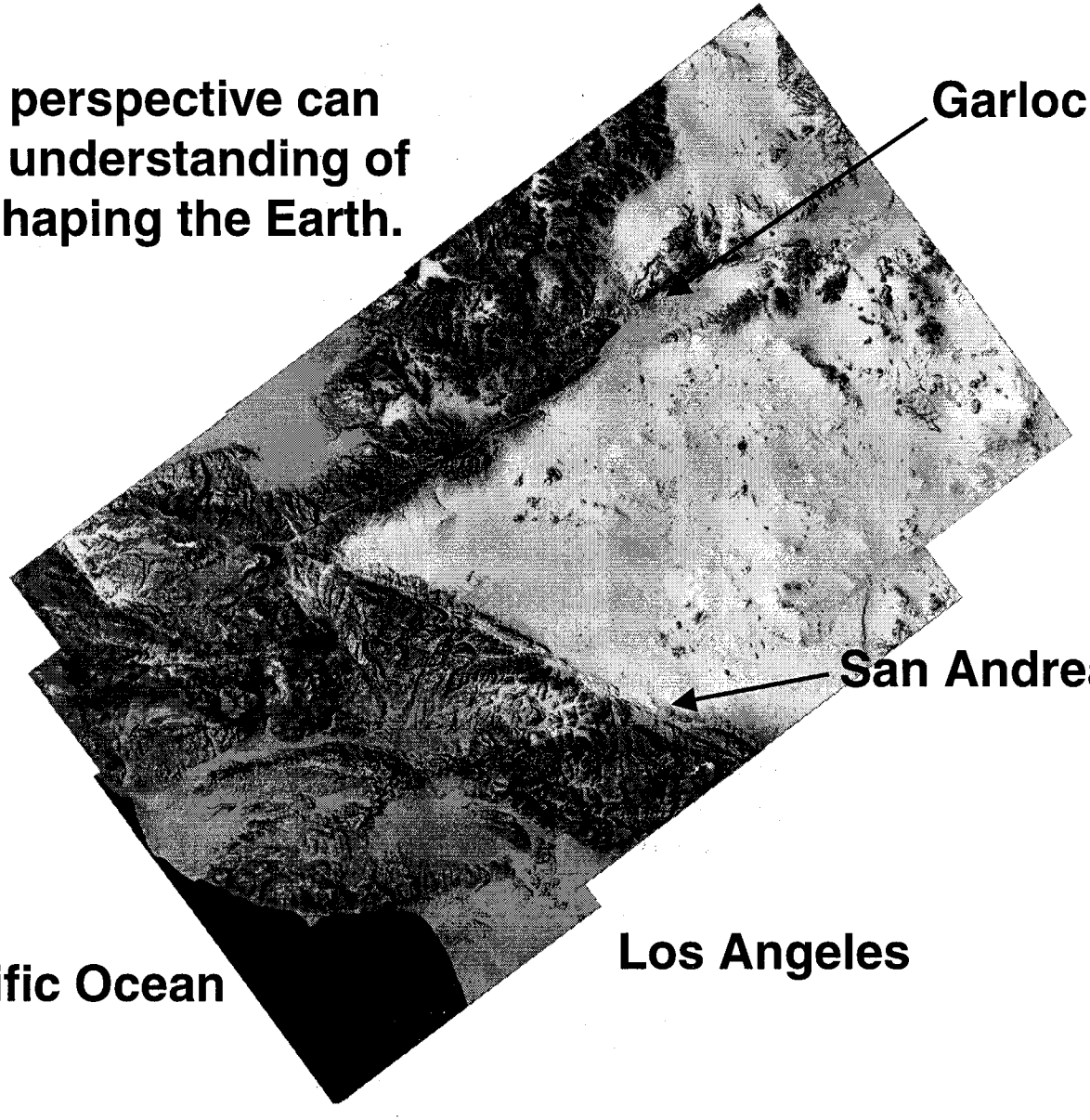
Mt. Pinos and San Joaquin Valley

San Joaquin Valley

Santa Barbara

Antelope Valley

Large scale perspective can lead to new understanding of the forces shaping the Earth.



Shuttle Radar Topography Mission

Simulated Flight along the Garlock and
San Andreas Faults, California
using SRTM C-band Topography and a
Thematic Mapper Image

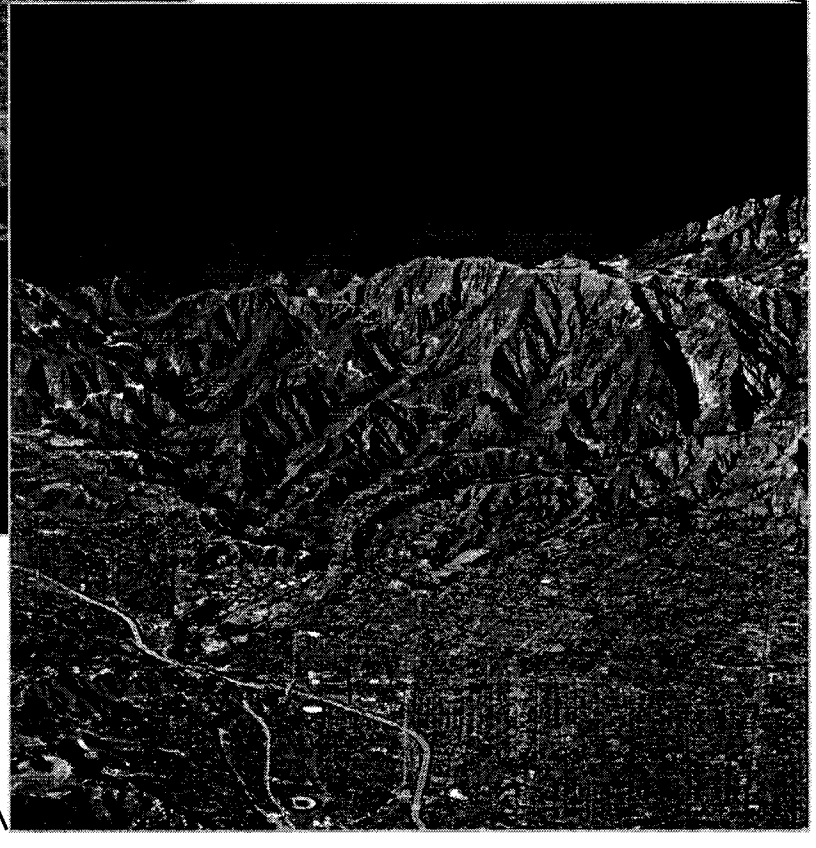
April 20, 2000

JPL

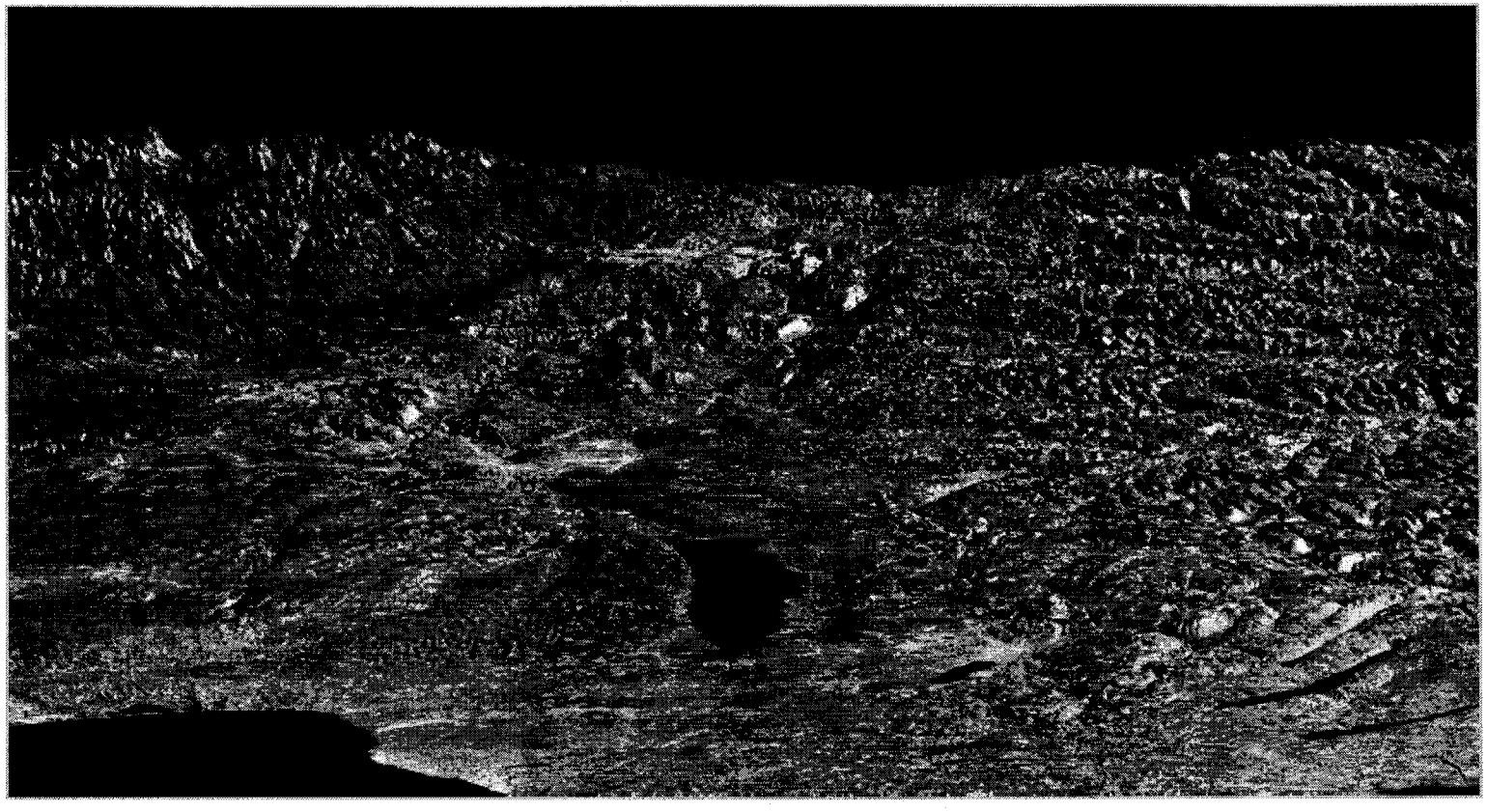
Greater Los Angeles

Landsat 5 overlay of SRTM topography

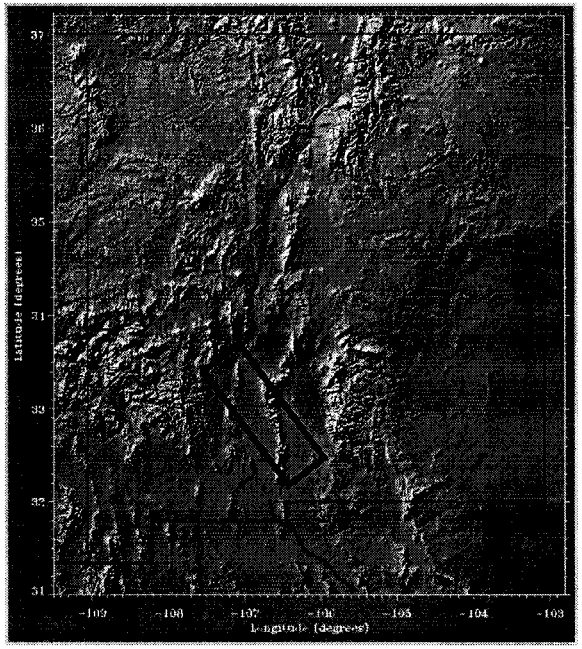
JPL and Pasadena



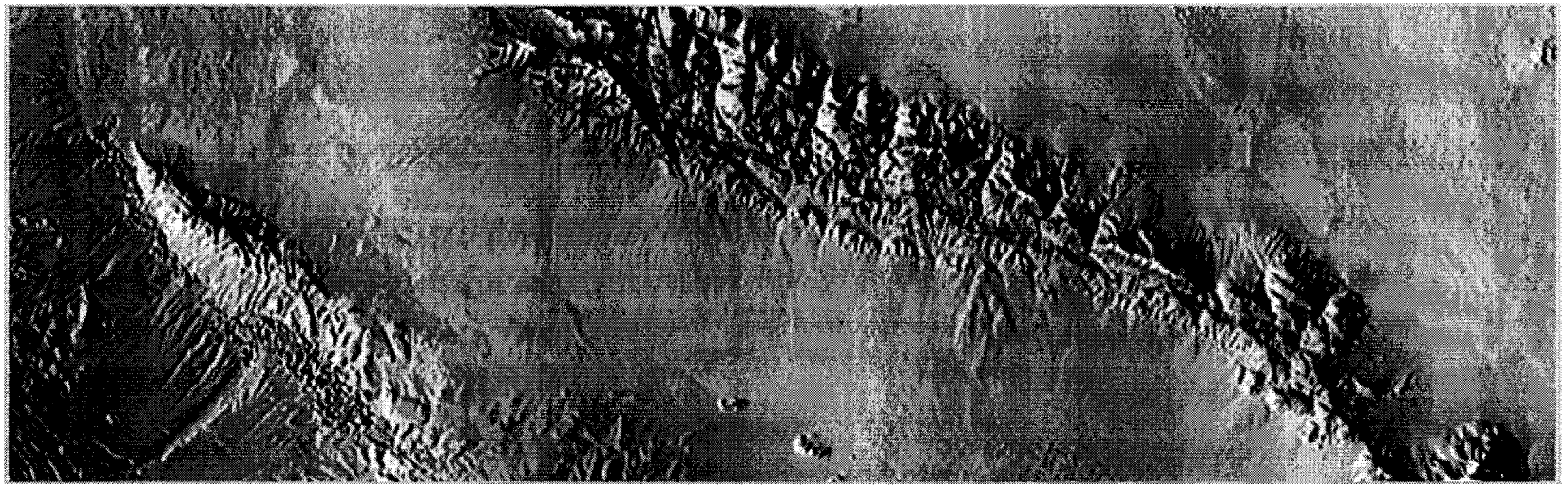
Landsat/aerial photo overlay

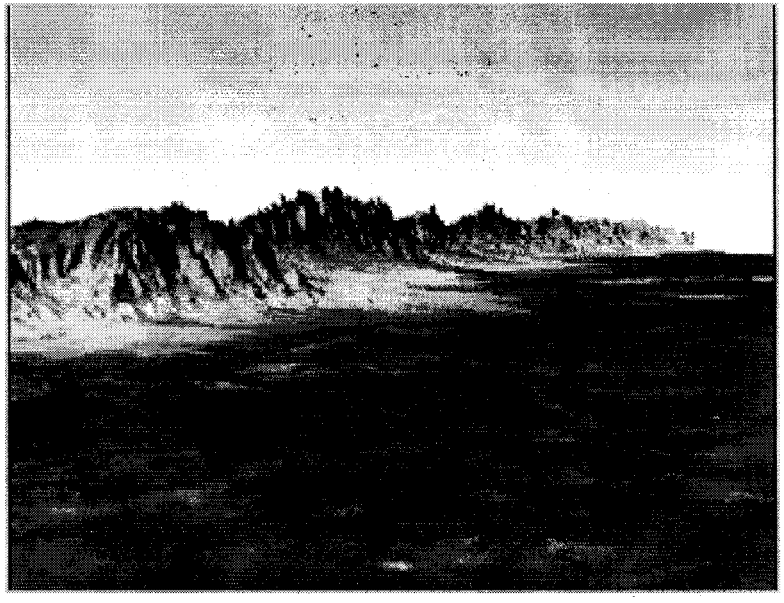


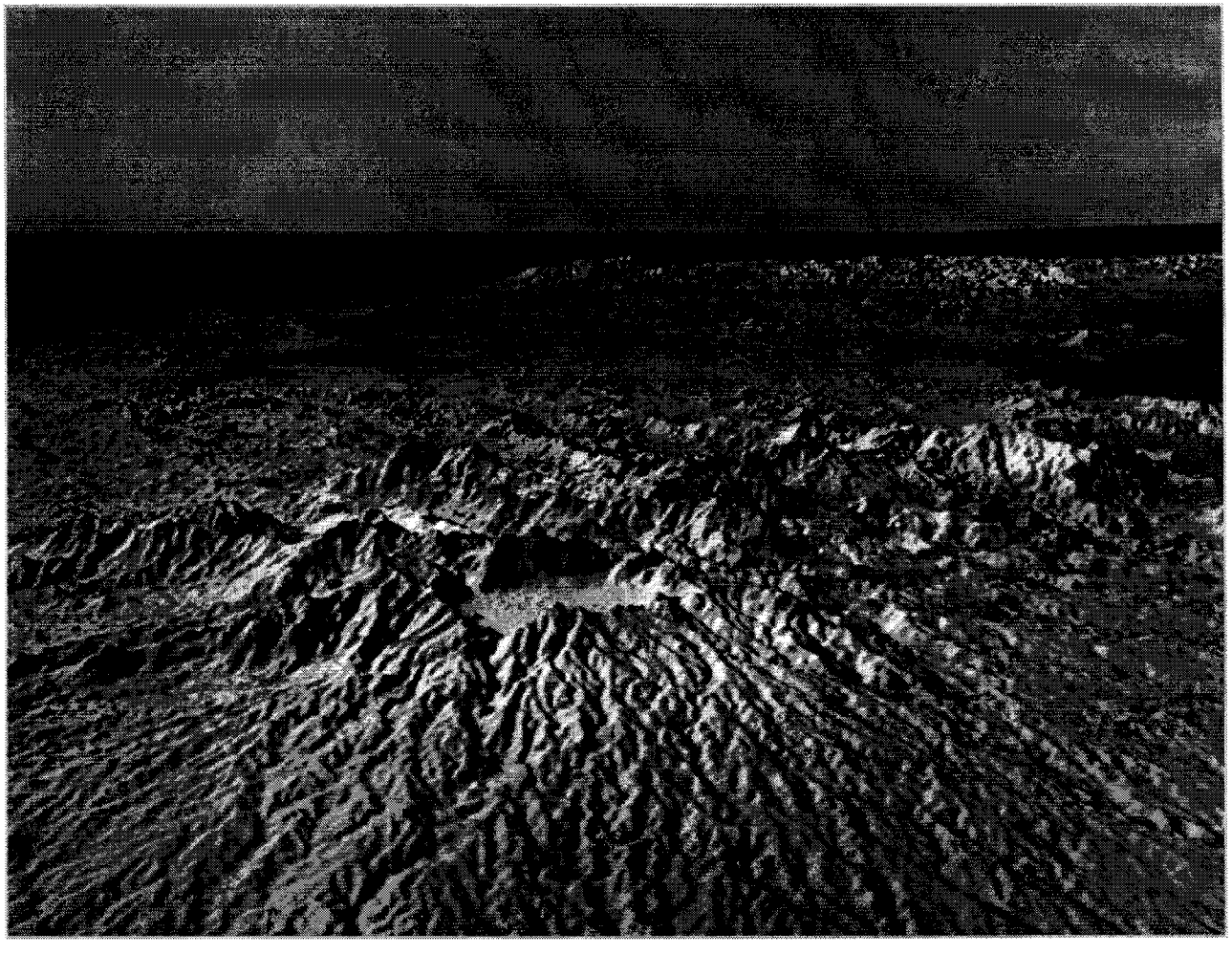
This perspective view of upstate New York shows Lake Ontario in the lower left, the Adirondack Mountains in the upper left, and the Catskill Mountains on the right. Oneida lake is just below the center of the scene. The image was generated using topographical data from SRTM and an enhanced true-colour Landsat image.



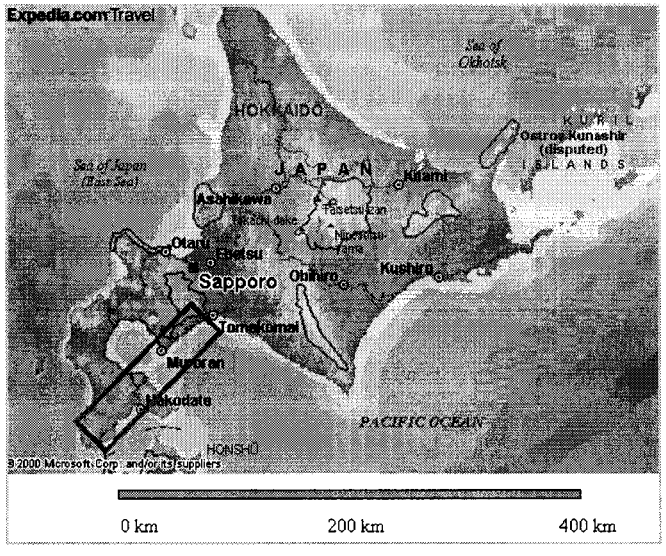
Coloured and shaded topography of central southern New Mexico. Colours range from green at the lowest elevations, through yellow and red, to gray at the highest elevations. The White Sands Missile Range is in the lower right corner of the strip, and the southern end of the San Mateo Mountains are at the left.



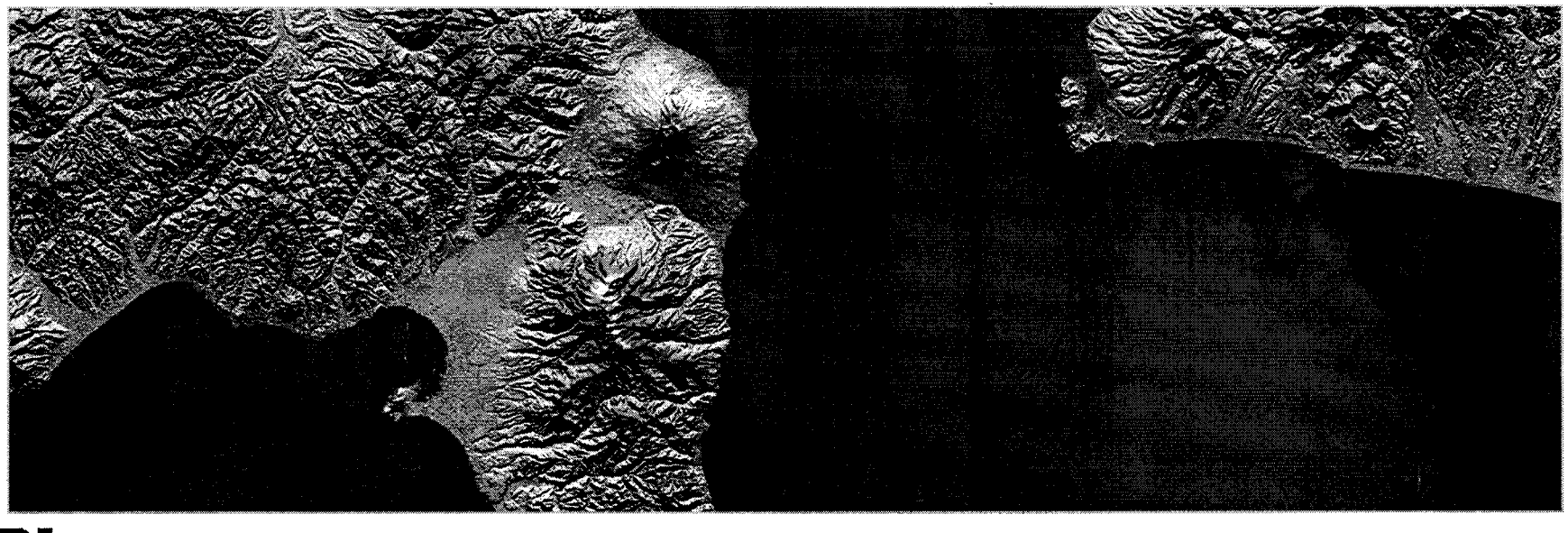


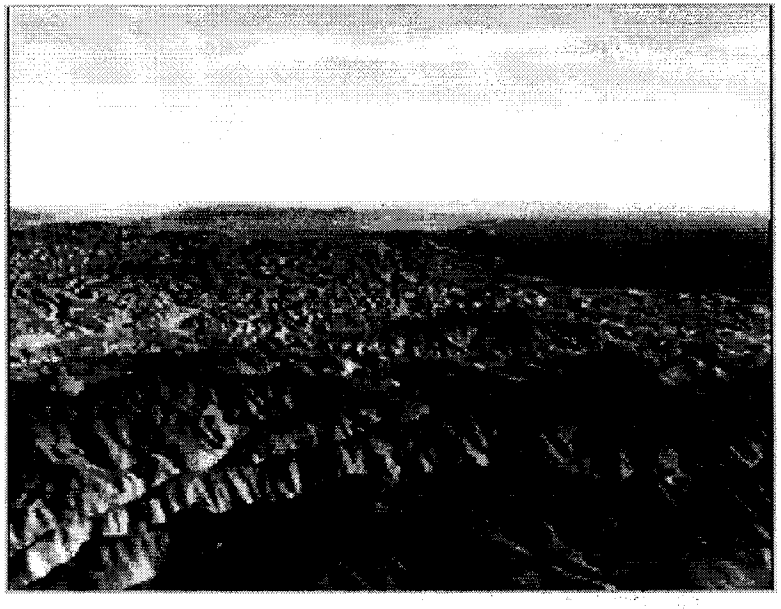


Shaded relief perspective view of the extinct volcano El Valle in central Panama, with Lake Gatún in the distance.

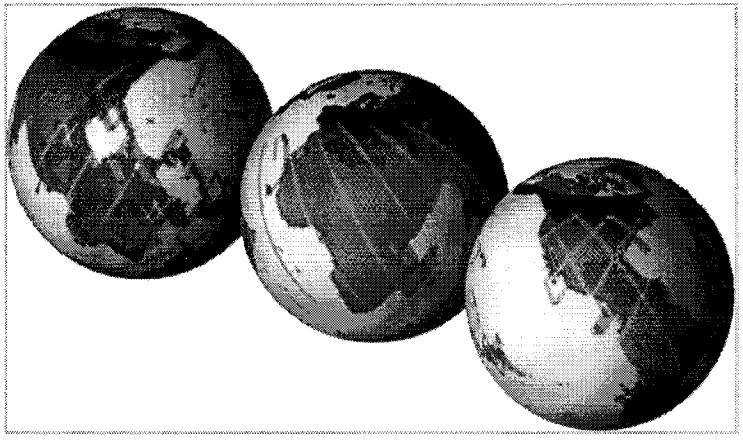


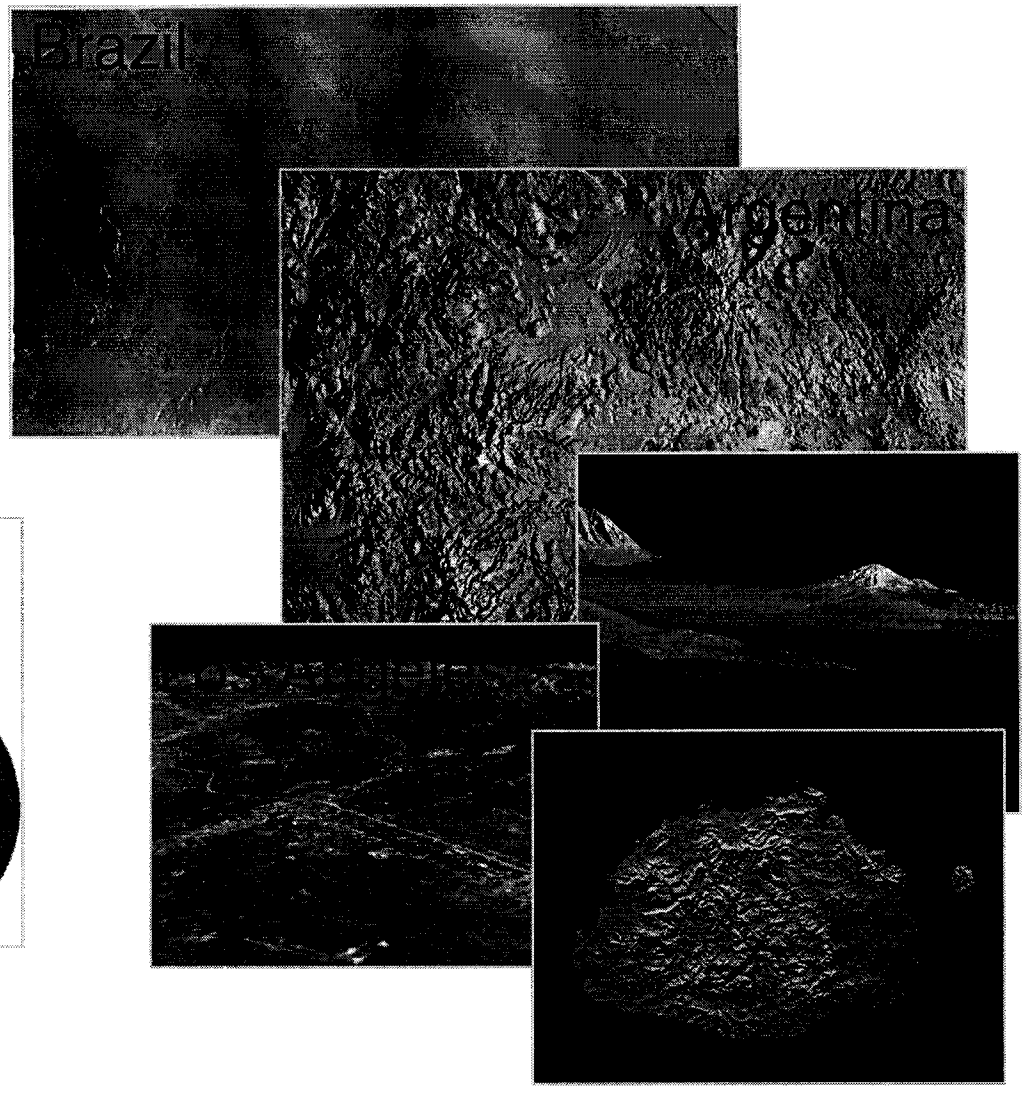
Coloured and shaded topography of Hokkaido Island, Japan. Colours range from green at the lowest elevations, through yellow and red, to gray at the highest elevations.

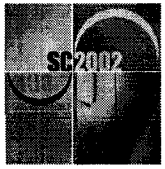


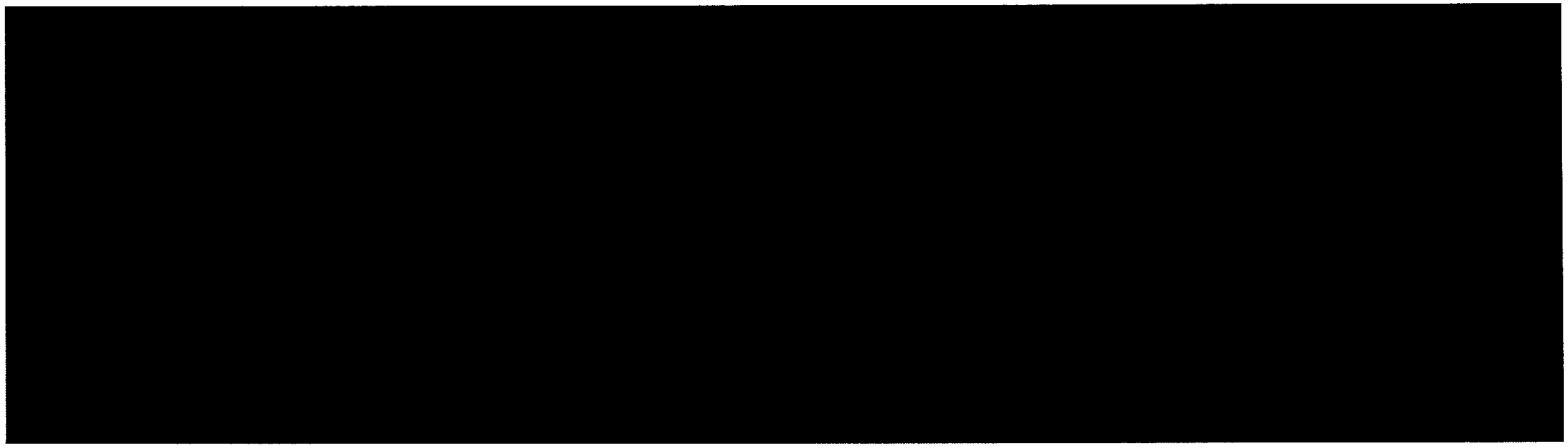


- Real-time products were generated during the mission.
- The mission achieved 99+% coverage of the planned area.









SRTM

SHUTTLE RADAR TOPOGRAPHY MISSION

NASA NIMA

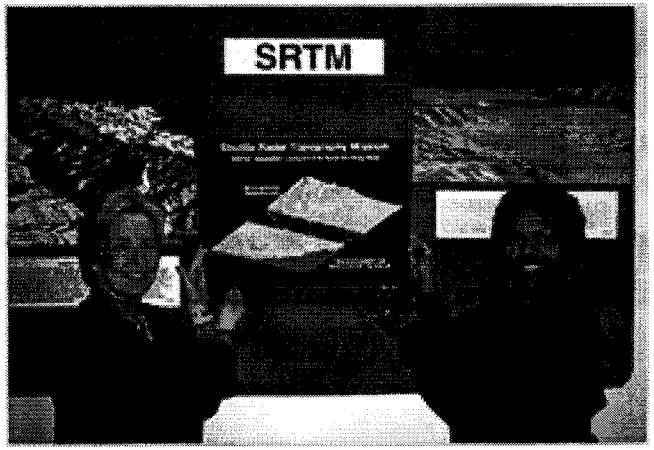
**** Mapping the World in 3 Dimensions ****

MISSION OBJECTIVE:

To obtain the most complete high-resolution database of the earth.

SRTM PAYLOAD:

The SRTM payload consists of radar electronics and antennas that operate from within the payload bay of the space shuttle, a mast that deploys out to 60 meters (200 feet) once the shuttle is in space and outboard antennas that are attached to the end of the mast.



JPL

- Mona Jasnow, SRTM Outreach Office, JPL.
- Dave Perz and Brian Swift, SRTM Data Processing Group, JPL.
- Eric DeJong and Shigeru Suzuki, SRTM Real-time Science Team, JPL.
- German Aerospace Center (DLR), Germany.